ADULTS AND NUMERACY

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ABSTRACT

This research critically develops ideas about "numeracy", "context" and "maths anxiety" from the areas of mathematics education, adult education and psychology. Many current views on the "transfer" of school mathematics to practical contexts are simplistic (e.g. the Cockcroft Report). Many studies largely ignore affect, or subordinate it to the cognitive, or consider only <u>expressed</u> anxiety.

A sample of undergraduates (many of them "mature") was used. In the quantitative phase of the study, the findings diverge somewhat from earlier work. Gender differences in performance, initially large, decrease in size (sometimes substantially) after controlling for maths qualifications, age, and social class. Statistical modelling produces an "inverted U" (rather than a simply negative) relationship between performance and anxiety. Factor analyses question earlier differentiations of "maths test anxiety" (academic) items from "numerical anxiety" (practical) items in the Mathematics Anxiety Rating Scale (MARS).

In the qualitative phase, the interviews synthesise life history and problem solving approaches; multiple readings are given to many episodes. Maths is indeed "hot": confidence, anxiety, pleasure and anger are often expressed. Drawing on psychoanalysis, I conceive of affect as emotional charges on ideas. The idea of "<u>exhibited</u>" (unexpressed) anxiety allows for e.g. the operation of defences. Drawing on post-structuralism, I see numeracy as quantitative, spatial aspects of thinking within everyday practices. The context in which a subject addresses problems, and/or reports anxiety, is described in terms of "positioning" in discursive practice(s). The analysis often shows a subject to be "multiply positioned"; thus what first seems to be "maths anxiety" can be interpreted sometimes as having other bases. The ability of a signifier to take different meanings within different practices suggests for example limits on the possibilities of transfer - while at the same time providing the basis for any such possibilities.

Overall, the quantitative phase focusses on general relationships between indicators assumed to be relatively stable, while basically accepting traditional frameworks for studying cognition and affect. The qualitative phase studies the processes of producing thinking and emotion; it explores and challenges many of the basic assumptions on which the quantitative phase rests. Thus, this study shows the value of using both types of research, both for questioning existing findings and assumptions, and for beginning to formulate alternative approaches.

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One of the messsages of this work is that learning, thinking and performance are social accomplishments: the production of this thesis is no exception. It is with appreciation and humility that I record my thanks to the following.

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CONTENTS

NOTES ON PRESENTATION

1. The thesis is arranged in twelve chapters. Whenever a section number is given - as in Sec. 2.1 or sec. 2.1.1 - the first number indicates the chapter.

2. For technical reasons to do with presentation, all Tables and most Figures are placed after Ch. 12, rather than integrated into the text.

3. In order to keep the main body of the thesis within word limits, some material is presented in Appendices, following the Bibliography. These are referred to in the main text, when relevant.

4. A Glossary of the variable names used in the statistical analysis of the questionnaire is given in APPENDIX R3.

5. The full transcripts of the interviews which provide the the basis for the seven case studies in Ch.11 are presented in APPENDICES S1 to S7. These transcripts were corrected and augumented by hand while listening to the interview recordings; only in one case was it possible to assimilate these corrections using a word processor.

6. All parts of the thesis are presented single-sided, except for the sample questionnaires (APPENDICES Q1 to Q3), and the interview transcripts (APPENDICES S1 to S7); page references made to interviews are to those of the original transcripts.

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CHAPTER 1 : ADULTS AND NUMERACY - AN INTRODUCTION

> There are indeed many adults in Britain who have the greatest difficulty with even such apparently simple matters as adding up money, checking their change in shops or working out the cost of five gallons of petrol. Yet these adults are not just the unintelligent or the uneducated. They come from many walks of life and some are very highly educated indeed ...
>
> (Stringer, 1979)

1.1 General Background to the Study

Concern over the mathematics curriculum and mathematics teaching has been a constant feature of debates in education throughout this century (see e.g. Howson, 1983). One relatively recent example comes from the then Prime Minister James Callaghan's Ruskin speech in October 1976 which launched the "Great Debate" in education:

> There seems to be a need for a more technological bias in science teaching that will lead towards practical applications in industry, rather than towards academic studies. Or to take other examples, why is it that such a high proportion of girls abandon science before leaving school ...? (Callaghan, 1976, p.5)

In response to similar concerns expressed by the Education, Arts and Home Office Sub-Committee of the Public Expenditure Committee in 1977, the then Labour Government announced its decision to establish an Inquiry into the teaching of mathematics "with particular regard to its effectiveness and intelligibility and to the match between the mathematical curriculum and the skills required in further education, employment and adult life generally" (Cockcroft Committee, 1982, p.ix).

These quotations illustrate the traditional view of "mathematical ability": it involves a set of generally applicable cognitive "skills", which can be deployed to perform a range of "tasks", in a variety of "contexts". These abstract mathematics skills are considered to be applicable in practical contexts through a relatively unproblematical process of "transfer". In any formal educational system, the issue of transfer of learning is clearly of major importance - whether in the "application" of school knowledge in contexts outside the school, or in the "harnessing" of outside learning to help with school aims. (Though the latter process has so far received less attention, it is bound to be increasingly crucial in systems where "mature students" or "recurrent education" are encouraged.) In this traditional view, performance is often considered to be measurable by the number of correct responses to a set of test items, such as those often used in schools. However, the possibility that correct performance could be produced by rote learning has led to the requirement that correct performance be produced, in a proper way, i.e. through "real understanding" (e.g. Skemp (1976, 1979)). (NOTE 1)

Research using the above ideas in mathematics education and psychology during the last twenty or thirty years has tended to produce the by now well-known findings to do with differences in performance in school mathematics (SM): e.g. gender differences in favour of males, and social class differences in favour of the middle classes. In the literature on gender differences, performance is normally explained with reference to cognitive, affective, and social variables (e.g. Fennema, 1979).

Much research on affect (and attitudes) has been carried out in mathematics education since the 1970s, often in order to help explain differences in "participation" or course-taking. These differences in turn have been advanced to explain the gender differences in SM performance, accepted as existing at least by the early teenage years in the U.S. and U.K. by many, though not all, researchers. (There has not been as great an emphasis on social class differences, during this period.)

Much of this research on affect has focussed on "maths anxiety". Anxiety as a concept has its basis in Freud's work which places crucial emphasis on the possibility that anxiety may be "latent" or unconscious. Psychology took these concepts, but stress on conscious, observable phenomena, in mainstream American psychology from the late 1940s, led to an emphasis on "manifest anxiety", which was considered observable and quantifiable. There was some debate over whether the different types of anxiety were simply "debilitating" of academic (and other) performance, or whether up to a certain level, anxiety might be "facilitating" of performance, as in the "inverted U" quadratic relationship representing the "Yerkes-Dodson Law". In the 1970s, because of both the theoretical role of maths anxiety in explaining the supposed performance deficits of certain groups, and (as I will argue) the methodological limitations of much earlier research, maths anxiety came to be seen as simply debilitating. From the late 1970s and early 1980s, there began to appear reports of work done with college students, on the relationship between maths anxiety and performance. These researches also studied possible "dimensions" of maths anxiety using factor analysis: sometimes two factors of maths anxiety were found (e.g. Rounds and Hendel, 1980), which can be seen as parallel to a distinction between school maths and practical maths.

Much research and curriculum development in recent years has focussed on how to promote the application of school maths in practical contexts; in particular, the report of the Cockcroft Committee (1982). Cockcroft used the term "numeracy" to focus attention on the "mathematical" aspects of <u>practical</u> everyday life, basing this in turn on research which they had commissioned, e.g. Sewell (1981). Of course, this is not to say that the interest in "practical maths" began with Cockcroft: there were already a number of projects with a similar focus, such as "Maths in Work" (NOTE 2) and the CSE Everyday Maths syllabus. (NOTE 3) However, Cockcroft opened up a space for the idea of numeracy - by inserting it into the traditional view. Using the term signified the Committee's view that the use of basic mathematical operations with confidence in practical everyday situations was essential to their aims - and also that the "transfer" from abstract mathematics to everyday applications was not as straightforward as the traditional view might suggest. Interest in out-of-school maths has greatly increased since the time of Cockcroft: studies have been carried out by the Brazilian school of Carraher, Carraher and Schliemann (e.g. Carraher, 1988); by "activity theorists" such as Scribner (1984) and Lave (1988); and by post-structuralists such as Walkerdine (1988).

Two major developments in adult education and further education during this period reinforced the interest in numeracy - the mushrooming of adult literacy courses, following the BBC series On the Move in 1975, and the development of "Access" courses. The latter aimed to allow adults disadvantaged by an unsuccessful school career to enter a specified course in higher education after an intensive preparatory course, rather than requiring them to complete O- and A-levels; they provided yet another source of demand for "maths" qualifications, or "numeracy skills" (or sometimes "statistical competence"). The adult literacy movement led to an awareness, starting amongst tutors, that a lack of "numeracy" existed as a widespread and important problem, somewhat independently of illiteracy. Thus numeracy became important in several contexts of educational policy-making. And it is undeniable that a lack of numeracy can be a great handicap, for individuals and for society; see the quotation at the head of the chapter and Evans (1989a) for a fuller discussion.

There are also sometimes problems with attempts to teach as numeracy what many adults recognise as "maths". Many students perceive there to be fairly strong boundaries between the maths that they have met at school or college, and the other activities that make up "real life" (or indeed other academic disciplines), even when the latter make substantial use of quantitative, spatial or other "numerate" ideas and strategies. And these people's feelings towards maths are often rather negative, e.g. feelings of lack of confidence, anxiety and dislike. It is reasonable to suspect that both the sense of "boundaries", and the negative feelings, will affect any possibilities of transfer between academic maths and practical activities. Thus, some recent research has stressed the "discontinuity" between school maths and numerate activity in non-school contexts, e.g. that of Lave (1988) and of Walkerdine (1988).

Despite a wealth of research being undertaken, there still seemed to be gaps that deserved attention in 1983 when I began this study. There remained problems with the notion of numeracy, for example, whether it was any different from elementary school maths with "a thin veneer of 'real-world' associations" (Maier, 1980). There was still relatively little research on adults as compared with that on the captive populations in compulsory schooling. The latter research had produced controversial and sometimes contradictory findings, e.g. on gender differences in maths performance and affect. And the research that there was on adults tended either not to pay much attention to affect, or else not to focus much on contexts outside the academic. Thus there seemed to be a need for research that would study cognition and affect, and their inter-relationship, amongst a group of adults who were both involved in academic maths <u>and</u> who were experienced in a wide range of practical activities that might provide a context for the use of ideas recognisable as "mathematical".

1.2 <u>The Developing Aims of this Study</u>

This thesis is about adult numeracy. My work began with the

broad problem: How do adults develop, or fail to develop, numeracy skills, and confidence in their numeracy? I began with a simple model which aimed to explain "difficulties with numeracy" by several factors or processes:
- socialisation depending on the individual's position in class, gender and other social structures of relations;
- critical incidents in one's history of learning maths; and
- affective characteristics (which I saw as representing a sort of internalisation of the pressures from the first two sets of determinants).
I aimed to attempt to produce (or gain access to) information that would allow me to describe the "level" of numeracy in the population of adults, or a reasonably representative sub-population; and to relate this to respondents' backgrounds, experiences, and "maths anxiety".

It seemed to me at the time that a suitably designed questionnaire, analysed using quantitative methods and modelling would meet many of these objectives. And it could be combined with "qualitative" (less structured) interviewing with several aims: to elicit descriptions of the sorts of everyday activities where subjects might use (or not) numerate reasoning; to describe in more detail critical incidents and experiences; and to illuminate the individual's more fluid perceptions, purposes and interests. The interviews would also allow me to describe how adults might re-emerge from their difficulties with numeracy to have a "second chance". Together questionnaires and interviews would provide an appropriate methodology.

As the research developed, it became clear that I would need to develop my concepts more fully, in particular: those of numeracy and "practical maths", along with the implied ideas about context; "performance" and cognition; and affect, especially anxiety and "maths anxiety". In response both to these conceptual challenges, and to the emerging limitations of the questionnaire results, I revised my aims for the quantitative part of the research, so that it would be focussed on the critical consideration of a number of earlier findings (mentioned in Sec.1.1) about mathematics performance and anxiety which are widely considered to hold.

The broad aim of the thesis is to understand adult numeracy, and how it is developed. Numeracy is not just low-level, applied mathematics: it is thinking, problem-solving in a variety of practical contexts, using concepts which are numerical, quantitative, spatial. I argue that, not only must the context be conceived more broadly than in much earlier work, but indeed it must be rethought as an integral aspect of activity, of numeracy-in-practice. In this view, the context is constituted by discursive practices, which tend to position the subject to address tasks and to act meaningfully. These discursive practices may be analysed best by focussing on language and signification.

In order to understand numeracy, I argue that it is essential to understand affect, emotion, feelings. Using the idea of affect as a charge connected to a signifier (or a chain of signifiers) in one or several specific discourses, I further argue that it is impossible to understand emotions such as anxiety or pleasure without allowing for the operation of unconscious processes. Using this overall approach, the relationship between the cognitive and the affective may be studied, for particular subjects positioned in specific discursive practices.

The broad aims of the thesis can be related to a number of objectives as follows. The aim of understanding and developing the idea of numeracy led me:
(i) to compare the several notions of "numeracy" relevant to different educational policy contexts;
(ii) to describe the levels of numeracy amongst a selected population of adult students, and to compare them with those of the national population surveyed for the Cockcroft Report; and
(iii) to consider critically a number of earlier findings about mathematics performance, numeracy and anxiety which are widely considered to be valid; for example, "Males perform better than females.... ", "Women have more maths anxiety..." and "Mathematics anxiety is debilitating".

Concern with a broader conception of context and its grounding in discursive practice pointed me:
(iv) to review the conceptions of "context" used in mathematics education and psychology, and to assess certain of these conceptions through empirical research;
(v) to contribute to the development of ways of describing cognition and affect in context, by proposing a methodology drawing on ideas from post-structuralism, and aiming to determine the practice(s) called up by subjects when they are presented with numerate problems.

The aim of understanding affect led me:
(vi) to document the range of affect related to mathematics and numbers amongst members of the sample; and
(vii) to illustrate the contribution of insights from psychoanalysis in the study of affect generally, and of anxiety in particular.
The goal of studying the relationship of cognition and affect led me:
(viii) to examine the relationship of cognition and affect, both across samples of adults, and for particular subjects.

In addition, I aimed:
(ix) to draw conclusions about the use of quantitative and qualitative methodologies in educational research; and
(x) to point to recommendations for mathematics education practice, and for the development of numeracy.

1.3 Overview of the Contents

In Ch. 2, I discuss the use of the term "numeracy" in various educational contexts, and the results of several recent national studies which use different conceptions of numeracy; I also briefly review the literature on gender and social class differences in mathematical performance. Ch. 3 takes up the discussion of affect, and in particular examines the development of psychological notions of anxiety and of mathematics anxiety: I review the research on the links between anxiety and performance, and on the "dimensions" of maths anxiety. Ch. 4 presents hypotheses based on the reviews and discussions in Chs. 2 and 3, and outlines the methodology for the quantitative strand of the research. Chs. 5 and 6 summarise the results of this strand, particularly those to do with gender and social class differences in anxiety and performance, the dimensions of maths anxiety, and the relationship between performance and anxiety; this is done first using descriptive statistics, and then using statistical modelling. This part of the thesis concludes with an Interlude which aims to evaluate the findings of the quantitative strand.

This discussion of the results of the quantitative strand suggests that the traditional notion of context might need to be overhauled. Therefore, Ch. 7 discusses the various uses of the ideas of <u>context</u>, and activity-in-context, in mathematics education (and other) research, and their relationship to the ideas of numeracy and "practical maths". Ch. 8 surveys conceptions of maths anxiety different to those discussed so far; in particular, the contribution of psychoanalysis is discussed, as is its combination with ideas of post-structuralism in the work of Walkerdine and others. These two chapters provide the basis for a set of "foreshadowed problems" or themes to be addressed in the "qualitative" strand of the study. Ch. 9 discusses these themes and the methodology for the interviews of members of the subsample. In Chs. 10 and 11, the results of this strand are presented, in particular those to do with the context-specificity of numerate cognition (or performance), affect (especially anxiety), and their inter-relationship - in the form both of cross-subject analyses (including all of the subsample) and intensive case studies. Finally Ch. 12 presents a summary and conclusions - contributions to theory, methodology, and pedagogy / practice.

CHAPTER 2 : NUMERACY AND MATHEMATICS PERFORMANCE

> I dropped mathematics at 12, through some freak in the syllabus [...] I cannot deny that I dropped maths with a sigh of relief, for I had always loathed it, always felt uncomprehending even while getting tolerable marks, didn't like subjects I wasn't good at, and had no notion of this subject's appeal or significance.
>
> The reason, I imagine, was that, like most girls, I had been badly taught from the beginning: I am not really as innumerate as I pretend, and suspect there is little wrong with the basic equipment but I shall never know.
>
> [...] And that effectively, though I did not appreciate it at the time, closed most careers and half of culture to me forever.
>
> (Margaret Drabble, writer,
> in The Guardian, 5 Aug.1975, p.16)

The broad aim of this thesis is to understand numeracy among adults, and to gain insights into how it is developed. I began by seeing numeracy as thinking, problem-solving, "performance" in practical (non-school) contexts, using ideas which are numerical, quantitative, spatial. The idea of context was an important part of my conception, and I considered that numeracy had affective aspects, too (see Ch.1).

In this thesis, adults are understood as people of a range of ages, including "adolescents", who:
(i) have a substantial range of everyday activities and

social relations, independently of their families;
(ii) have at least the opportunity for paid or voluntary work; and
(iii) are conscious of having social or political interests. Thus, in the teaching situation, we often hear the question: "How is this useful to me?". (In contrast, children's experiences tend to be more homogeneous). At the beginning, I was interested in the population at large of adults - though the practical constraints of doing empirical research soon led me to choose a population that would allow a compromise between representativeness and convenience; see Ch.4.

Although there is a great deal of information available on the mathematical attainments of school children of various ages in the UK (some of which will be reviewed in Sec. 2.3 below), there is relatively little empirical study of adults' "mathematical performance" or adult numeracy. Such studies are done mainly with students in tertiary education or in adult education, or occasionally with members of the general public (see Sec. 2.2). In tertiary education, it is mostly mathematics performance that is studied - whereas in adult education, studies have tended to focus on numeracy; this is no doubt partly because of the attention focussed on it by the Cockcroft Report (1982), and partly because numeracy seems to provide parallels with literacy (NOTE 1).

The term "numeracy" was used before the publication of the Cockcroft Report (1982), but the latter opened up a space for it to be discussed widely inside and outside of education. However, the term has been used in several different ways. I shall examine these in Section 2.1. To date, very few studies have been done on numeracy in the adult population at large, and those have used different notions of numeracy. I consider the conceptual basis and results of several studies in Sec. 2.2.

I also aim here to begin to develop explanations of how numeracy (allowing for its different senses) is developed. In Sec.2.3 I delve selectively into literatures on gender differences in particular, and also into those on social class and age differences in mathematical performance, including studies of school-age groups (NOTE 2). Thus, in this chapter and in the discussion of affect in Ch.3, I build up a "conceptual map" that summarises a set of plausible explanatory factors for differences in numeracy and mathematical performance, and that can be used as a basis for designing the questionnaire in Ch.4.

2.1 Numeracy and Mathematical Performance among Adults

In sec. 2.1.1, I consider the different notions of numeracy current in different educational settings, and in sec. 2.1.2, I begin to consider the related ways that contexts of numeracy are conceived.

2.1.1 Concepts of numeracy and practical maths in several contexts

There was little research at any age level based on the idea of numeracy before Cockcroft, though the term was used in adult education. Where it was used, it seems to have referred to basic numerical skills, and to have been tested by fairly abstract questions; e.g. in Glenn (1978) for adults, and in Pollock and Thorpe (1979), in a study of school-aged pupils in Scotland.

(a) the Cockcroft Report (1982)

Cockcroft's brief mentioned the "(mathematical) skills required in further education, employment and adult life generally" (p. ix), but Ch. 1 of the Report makes no mention of "numeracy". In Ch. 2, the Committee indicates that they include among the mathematical needs of everyday life the abilities: to read numbers and to count; to tell the time; to pay for purchases and to give change; to weigh and measure; to understand straightforward timetables and simple graphs and charts; and to carry out any necessary calculations associated with these. They also stress the importance of having

- a "feeling for number" which permits sensible estimation and approximation and which enables straightforward mental calculation to be accomplished, and
- most important of all, "sufficient confidence to make effective use of whatever mathematical skill and understanding is possessed" (paras 32-34, p.10).

In the next section of their Report, the authors indicate that "numeracy" was mentioned by many submissions - but generally in the narrow sense of being "able to perform basic arithmetic operations" (Collins Concise Dictionary), rather than in the Crowther Report's (1959) broader sense, as the "mirror-image of literacy" - including familiarity with the scientific method, thinking quantitatively, avoiding statistical fallacies. Taking an intermediate position, Cockcroft define the word "numerate" to mean the possession of two attributes:

- first, an "at-homeness" with numbers, and an ability to make use of mathematical skills which enables an individual to cope with the practical mathematical demands of his everyday life; and
- second, some appreciation and understanding of information which is presented in mathematical terms, for instance in graphs, charts or tables or by reference to percentage increase or decrease.

That is, they are concerned with "the wider aspects of numeracy", and not merely "the skills of computation" (para 39, p.11).

There are several noteworthy aspects of this definition. First, both affect or attitudes - an "at-homeness" - and skills are considered important: <u>familiarity</u> and <u>confidence</u> count, as well as competence. Second, the criterion for which skills are important is practical: are they relevant to the demands of the <u>context</u> of the person's everyday life? And third, their notion of numeracy includes the <u>appreciation</u> of numerical <u>information</u>, as well as the use of techniques, and this appreciation is implicitly critical.

The reception given to the Report shows that the Cockcroft Committee succeeded in opening up a "space" for numeracy in the traditional discourses about mathematics education. By choosing to use a previously little-used word, the Committee signified their view that the mere "skills of computation" were not sufficient, but rather the <u>use</u> of mathematical operations in <u>practical</u> everyday situations was essential to their aims. The use of a new word also implies that the "transfer" of skills from abstract school maths to everyday applications is not as straightforward as the traditional view might suggest. However, the Cockcroft Report does not abandon the traditional view altogether: their definition of numeracy still holds to the idea that what inheres in numerate practical activities nevertheless still <u>is</u> mathematics. This has been called the <u>utilitarian</u> view of the relationship between school mathematics and "practical mathematics" (see Dowling, 1991 and Ch.7 of this thesis).

(b) adult education

The term "numeracy" began to be used in adult education during the mid-1970's adult literacy campaigns, when adult numeracy problems became evident in their own right. (Rees and Barr, 1984, p.193; <u>The Guardian</u>, 14 May 1987, p.23). Sometimes, the expression "functional numeracy" is used to emphasise its applied or practical nature (cf. "functional literacy").

Glenn (1978) considered numeracy to be "an integrated set of mental skills and understanding" that could be defined only by listing its component skills. He presented a set of behavioural objectives, for example:

I.12 Add without error using an algorithm any two multi-digit numbers.

II.14 Multiply any decimal by an integer of one or two digits.

As can be seen, the context was usually unmentioned, or at most vaguely specified as e.g. "a suitable context" (pp.126-131). This approach is firmly based in what has here been called the traditional view, which assumes that if the "basics" are learned properly in their abstraction, they can be applied in any appropriate context at will.

On the other hand, Brigid Sewell used "functional mathematics" to emphasise the practical usefulness of maths, in distinction to the "abstraction" of its concepts, as used by mathematicians (1981, p. 1). ("Numeracy" was reserved as the name of the provision within adult education which aimed "to help adults handle with confidence such mathematics as they encounter in daily life".) Sewell presented no (explicit) list of skills included in numeracy. But an important feature of her work was the attempt to produce problems in practical contexts which she aimed to portray by the use of wording, tables and graphs, and other "props" in the presentation.

<u>Adults' Mathematical Ability and Performance</u> (A.C.A.C.E., 1982), the report produced for Cockcroft, does not use the term "numeracy". But it urges a "functional approach", rather than "formal manipulation" (p. 57). It aims for "some indication of the national level of adults' mathematical ability", reporting on a survey of almost 3000 adults conducted by Gallup (see next Section), and a more intensive study of about 100 adults done by Sewell (see sec. 7.2.1).

We might call the dictionary definition of "basic arithmetic operations" (see above), or the characterisation of numeracy by Glenn, <u>basic skills numeracy</u> or "N0"; and the sort of "functional mathematics" referred to by Brigid Sewell, including some of Cockcroft's "everyday mathematical needs", might be labelled <u>functional numeracy</u> or "N1".

Withnall et al.'s (1981) definition of numeracy, "efficiency in mathematics relative to the tasks to be achieved" (p.30), is supportive of the emphasis on the practical / functional in the interpretations of Cockcroft's ideas above. But it also suggests that there is no definition in abstract terms

that will be generally valid for _everyone_. They also argue that adult innumeracy cannot be fully explained by weakness in school maths, as measured by school tests (p. 2) - for several reasons :
(i) adults use numeracy in a variety of social contexts, which could not be anticipated by school maths;
(ii) adults may lose certain school maths skills through lack of sufficient use;
(iii) society's definition of a minimum adult level of attainment may change (NOTE 3);
(iv) lack of confidence may be as important a problem for adults as lack of knowledge; and
(v) the errors made by adults may differ from those made by children - sometimes because adults' greater knowledge and experience may make simple problems more complex (p. 7).

Ros Penny also is critical of using a list of everyday maths skills as a definition of numeracy : it tends to be seen as a limited and limiting coping skill; and numeracy needs to be seen in a wider context related to the potential self-development of the individual concerned (1984, p. 23). Riley (1984), too, is concerned at the way the idea of "functional numeracy" is sometimes seen as applicable to all stuents at all times : "To present a student with a worksheet on costing a holiday in Wales when in fact he or she is going to Majorca, or is unemployed and is going nowhere, is a travesty of the functional approach.... To be truly functional the work must derive from the student." (p.2). This suggests the need for a distinction in functional numeracy, depending on whether the relevant capabilities are seen as able to be defined _in general_ (N1g), or needing to be specified _for a particular individual_ (N1p).

Willis (1984) himself considers a series of successively broader definitions of numeracy, in his discussion of the ALBSU / NCDS survey (see next section). He acknowledges what I here call N0 and N1 - but also goes on to mention other aspects of numeracy which seem important to him:
- moving beyond "feelings of inadequacy, worry, helplesness

with numbers";
- a "feel for numbers": e.g. to see that "5 times 95p is not far off £5 [... or] a 12% surcharge is not far off a 10%";
- the ability to tell what sum needs to be done (p.19); and finally,
- the ability to apply these skills not only to personal matters, but to society:

> ... the state and large corporations and institutions dominate our lives more than ever, and the decisions they take nearly always have some mathematical justification. We need to be able to participate in the arguments, to use numbers to argue on our behalf in the same way as those in power often use them to advance their own particular causes. In a society where the power of numbers is supreme and the need for numeracy all-pervading, most of us are more or less <u>in</u>numerate. (p.20; his emphasis)

Willis' emphases are echoed by Gabony and Traxler (1982). They characterise numeracy as being "concerned with numbers (or more properly quantity and relationship) which have a direct application to real life", and as being made up of four equally important inter-related parts:
- the exact manipulation of abstract quantities;
- approximating and estimating within a calculation;
- the feel for numbers as part of the real world, involving "a sense of how heavy a kilo feels, how far a mile is";
- developing skill in selecting the appropriate strategy to deal adequately with problems, which "depends clearly on literacy, social and cultural cues." (1982, p.iv)

These authors from within adult education clearly hold the view of numeracy as functional maths - i.e. N1. They support the emphasis in Cockcroft on:
- practical "skills" - e.g. <u>approximating</u> and <u>estimating</u>; and
- its affective aspects - in particular, <u>confidence</u> and <u>familiarity</u> ("a feel for numbers") (NOTE 4).
However, they explicitly extend practical skills to include

what might be called _modelling_ the problem, selecting the appropriate strategy or operation. And some give numeracy a critical "political" edge (see the Willis quote above).

(c) vocational education

The work of Ruth Rees and George Barr (1984, 1985) emphasises the diagnosis of difficulties in particular topics (e.g. multiplication and division of "small numbers" between 0 and 1, area and circumference of circles, "context" in problem-solving) which they claim form a "core of difficulty" for students of all age groups. It is based on work over many years with diverse groups of students; e.g. Rees (1973) studied almost 18,000 City and Guilds maths exams, especially of craft and technican students.

Rees and Barr (1984) discuss "numeracy" only in the penultimate chapter (Ch.11 "Adults and Numeracy"). Their characterisation of numeracy can be inferred from their aims for students on the City and Guilds numeracy scheme:

- a minimum standard of numeracy required for day-to-day living and working;
- confidence in their ability to learn and to manipulate numbers;
- coping with further work in calculations required for present and future study; and
- "transfer" of number skills learned into new situations (1984, p.195).

Rees and Barr (1985) cite similar aims for the Certificate of Pre-Vocational Education numeracy core. They also state that numeracy forms part of elementary mathematics. However, computational skills have to be based on "understanding" if they are to be applied to problem solving in real-life settings (1985, pp.1-3).

Thus Rees and Barr's view of numeracy is NO (emphasis of basic calculations and manipulation of numbers) - and they stress "transfer" to other subjects and to new situations (everyday living and working). This again is a statement of the basic traditional view: if the mathematics is learned properly in its abstraction, then the applications will follow.

This concern with "transfer" is at least implicit in most of the positions referred to in this subsection - in particular in N0 and N1. Some would argue that the assumption that it takes place is necessary as a basic part of the justification of schooling and formal education generally (e.g. Lave, 1988). The discussion of transfer requires a fuller discussion of the idea of context.

2.1.2 The context of maths and numeracy : beginnings

The idea of context is important in this research because part of the definition of numeracy developed above is that it relates to practical everyday contexts. Until the early 1980's, the exploration of "context" in mathematics education appears to have been confined to school contexts, and to have been focussed on the use of logic (e.g. in Wason's "selection problem" - see Bell et al., 1983, Ch.2), and on variations in wording in word-problems (e.g. in the work of Nesher and others - see Bell et al., Ch.6). However, context has recently been discussed in a much more wide-ranging way in mathematics education circles. For example, both Cockcroft and Withnall et al. (1981) distinguish, at least to some extent, between school maths and the "everyday life" or "social contexts" in which adults use numeracy. Here I consider the ideas of context related to the two ideas of numeracy discussed in the last subsection - namely, N0, as in Rees and Barr's work, and N1, as in the APU's.

Rees and Barr's work is based on the "N0" view of numeracy as a set of abstract basic skills, largely to do with arithmetic calculation, which are assumed to be be applicable in a range of practical contexts. Teaching adults numeracy skills which "transfer" means exposing "students to different contexts which have the same mathematical content" (1984, p.195). (NOTE 4a) Examples of contexts are:

electrical work, painting and decorating, and O-level maths at school. The challenge for tutors is thus "to bridge the gap between using computational skills in pure form and their application in real-life settings, i.e. problem solving." (1985, p.3). Thus they seem to consider the mathematical content to be neatly separable from the context, and to be unaffected by it.

For Rees and Barr, the context of a task can be captured by the wording of the problem: their book says almost nothing about the conditions in which the various groups, whose patterns of answers are compared, actually did perform. For them, a problem such as "8 / 0.16" can be said to have a "pure" context, or no context at all (1984, pp.177-8).

Rees and Barr discuss "impact perception": "the way in which the learner first sees the task ... <u>can colour the whole route to solution</u>" (1984, p.5; their emphasis). They argue that an initial misperception of the task can have longlasting negative effects. This idea <u>might</u> be taken to suggest that the person's initial perception of the type of problem is part of what constitutes the context - but I read them as implying that there is only one correct perception of the problem.

At one point, however, they reveal that their early work found that "embedding the mathematics in context appeared to create some tasks that had core of difficulty characteristics, and some that had not" (p.176). This might suggest that what appears to be "the same" task (in terms of mathematical content) is a <u>different</u> task in different contexts. But they don't follow up the implications of this for their view of a radically clear separation of content (mathematics) and context. Rees and Barr stick with the idea that the mathematics "skills" can basically be considered in their pure form - that is, as <u>context-independent</u>.

The Assessment of Performance Unit (APU) studies have distinguished three types of context: "mathematical"; "everyday"; and "other subject". "Everyday" is used in a broad sense to include "situations which every pupil is likely to recognise, but will not necessarily have experienced" (Foxman et al., 1985, p. 833). Thus, this is a general categorisation (based on the idea of "N1g"), and is not based on evidence of the familiarity for any particular pupil, or even for most.

The APU's work allows the notion of context to be developed in a number of ways. First, they suggest that the categories may _not_ be "independent" (i.e. _mutually exclusive_): work on maps may be seen as both mathematical and geographical (p. 833). Second, they include in the "context" not just the wording of a problem, but also maps, diagrams and _presentation_ generally (pp. 833-835). (The same was done in Brigid Sewell's "second interviews" (see Ch. 7 below), and in the questions used in the ACACE / Gallup survey based on her work (see the next section.)

Third, they attempt to _differentiate_ particular everyday contexts, notably contexts involving money from the rest: the latter normally boost success rates especially for the more difficult operations such as division with decimals. This may be because money is one context in which all pupils have had some experience, and with which they are _familiar_; pupils also approach money computations with more _confidence_ than calculations in maths or in other settings (pp. 836-8). Fourth, mathematics presented "in a context" can help or hinder depending on the context and the concepts involved (p. 838). The APU's detailed results allow us to explore these "effects of context" on pupil's interpretation of problems and their performance. (NOTE 5) Finally, the APU researchers sometimes found that the pupils' responses were based on "social, rather than mathematical reasoning" (p.447), and that some of the problems were _perceived_ as "common sense", rather than mathematics by pupils (p. 838).

The APU analysis still tends to view content and context as separable, much as did Rees and Barr - but not always!

We know that money contexts get higher success rates

> than other contexts using decimals because, in the former, decimals can be avoided by thinking of £x.yz as £x and yz pence or xyz pence. Thus the task is different in money as compared with other contexts because the methods used in each case are different.
>
> (Foxman, 1988, personal communication; my emphasis)

To summarise, we can compare Rees and Barr's work, and that of the APU. Rees and Barr's idea of numeracy (N0) stresses the context-independence of abstract basic skills. This is related to the idea that the mathematical content of a problem and its context can be separated. Though the APU share this view to a great extent, their emphasis on specifying and differentiating particular everyday contexts, as well as the occasional hint of a distinct view of tasks and "skills" as somewhat more context-dependent (see above), is the basis of my classifying their view of numeracy as N1. (In Ch.7, I shall discuss the ideas of context in the work of several researchers who see a clear "discontinuity" between "maths" in school contexts and in practical ones.)

Further, both teams see the context as rather obviously defined, based on "natural" settings - such as electrical work or O-level Physics at school - and as able to be read off from the wording etc. of the problem. The APU extends the wording to include the mode of presentation generally. However, the APU work has also produced data in different modes: written tests; questionnaires (for attitudes); one-to-one practical interviews; and small group practical interviews (from 1987). (This points to ways of researching a broader idea of the context of mathematical performance; see Ch.9.)

These works seem to begin from a fairly determinist position concerning the "impact" or "effect" of contexts on pupils' interpretation of problems, and on their performance. At the same time, they also suggest the importance of the part played by the student's perception of the task in the way that the context is constituted. (However, it is difficult, if not impossible, to explore how and why subjects perceive particular items as they do, in large-scale testing, or questionnaire research.)

Finally, both bodies of work support the conjecture that the familiarity of the context for respondents, and the confidence with which it is associated, will be related to performance in the solving of problems. However, on the basis of the discussion so far, it seems difficult to specify that relationship with any clarity.

2.2 Surveys of Numeracy among Adults : Some Results

Over the last ten years, there have been three large-scale and broadly representative surveys, which allow us to assess adults' skills in numeracy in the U.K. They also can help to estimate inequalities in this area related to social class, gender, and age.

2.2.1 The ACACE national survey for Cockcroft

The Gallup survey which formed part of the evidence submitted to Cockcroft by the Advisory Council for Adult and Continuing Education (ACACE) recruited a sample of almost 2900 adults in February 1981 (NOTE 6).

All ten of the questions were meant to test everyday or "practical" maths; they are given in APPENDIX P1. Overall, six of the questions had to do with spending money in shopping or eating out; viz. Qus. 1, 2, 3, 5, 8, and 10. Two further questions were clearly practical: Qus. 6 and 7, about reading a rail timetable and understanding "inflation", respectively. And the two parts of Qu. 9 which required the reading of a graph about temperature changes also seemed to be practical. On the other hand, Qu. 4 seemed rather more "abstract", like school maths, in that it asked for which number was greater, without giving any units. The results analysed by sex age and social class (measured by market research categories (Reid, 1981, pp.56-57) which relate closely to the Registrar General's occupational rankings from I to V) are given in Table 2.1(p.428; NOTE 9).

We can summarise the results as follows:

* The questions on simple operations, percentages and graphs were answered correctly between 64% and 88% of the time, but Qus. 6 (reading a train timetable) and 7 (explaining the meaning of inflation) were answered correctly only 55% and 40% of the time respectively;

* men did better than women, and the difference - between 2% and 20%, depending on the question - was largest on Qus. 4 (deciding which "abstract" number is larger), 6 and 3 (calculating a 10% tip on a restaurant bill) (NOTE 7);

* the young, especially the 25-34 age group, generally did better, and the over 65s least well - though the difference was less on "money" questions like Qus. 2 (multiplying) and 5 (dividing);

* social classes AB (professional and intermediate occupations) did best and classes DE (semi-skilled and unskilled) did least well - with the difference greatest for Qus. 3, 6, 7 and 9 (reading graphs). (NOTE 8)

This survey provides further information on the three aspects of numeracy discussed above (see Sec. 2.1). First, though posed in a formal interview situation, all of these questions (possibly excepting Qu.4) involved reasoning which might be required in an everyday "practical" situation.

Second, in addition to the responses themselves, interviewers recorded whether each response was made in a "confident" or "unconfident" way, and whether "immediately" or after a pause for thought. In general, the higher the proportion of correct answers in a group, the more confidently and immediately the answer was given.

Third, though none of the questions required skill in critically assessing numerical information before doing calculations with it, Qu.7 addressed the meaning of the notion of inflation. It was by far the least well answered question. Any of the wrong answers would almost certainly indicate that the respondent was substantially confused over an issue which has been widely discussed over the last 15 or 20 years, and which the current government had specified as a top priority. Of the 54% of people answering this question incorrectly, about one third (or 17% of the whole sample) gave response (d): "Prices ought to have gone down, but didn't." This particular incorrect answer is clearly based on a confusion between the level of prices and the rate of price rises (as is response (a): "Prices would have gone down"); it may also feed into despair (and perhaps cynicism) on the part of respondents that their expectations are not satisfied. (For further discussion of the national survey results, as compared with those of the Polytechnic survey, see Sec.5.2).

In 1990, the Basic Skills Accreditation Initiative survey was carried out (NOTE 10), using similar questions to those of the ACACE, and obtaining similar results. For more detail, see APPENDIX V2.

2.2.2 The ALBSU Analysis of the NCDS 4th Follow-up

The National Child Development Study (NCDS) is based on all those children born in one week of 1958 (e.g. Fogelman, 1983). The 4th follow-up interviewed some 12,500 23-year-olds in 1981, and provided data for the ALBSU study discussed here (Simonite, 1983; Hamilton and Stasinopoulos, 1987; a fuller description of the NCDS and results from the earlier follow-ups will be given in Sec. 2.3.).

The 4th follow-up used a conception of numeracy which I called in the previous section "N1p", and which flowed from a concern with individual needs. It asked respondents self-rating questions - whether they had had problems with numeracy ("number work" or "basic maths"), and with literacy ("reading", "writing" and "spelling") since leaving school; for the full questions, see Appendix P2. This was done in preference to producing examples of everyday problems, as the ACACE study (reported above) did. It was justified by Alan Wells, the Director of ALBSU at the time of publication of the detailed results: "People who say they've got problems - that's not a bad definition" (The Guardian, 14 May 1987). Furthermore, the drawback of the ACACE approach was considered to be that the competences measured "vary from task to task and may not be relevant or representative of the problems faced by people outside the community (or time) they were originally designed for." (Hamilton and Stasinopoulos, 1987, p.8). Thus no standard questions on numeracy and literacy were presented in this follow-up of the NCDS, though standardised tests of Maths and English had been given to respondents at age 11 and 16; see Sec. 2.3.

On sampling, the fact that the NCDS is based on all children born in a certain week means that the researchers were not restricted to an "available" group of adults, such as those registering for adult education courses - which would be likely to produce a bias. However, of course, the survey included only 23-year-olds.

For the results from the study, see Table 2.2 (p.428; NOTE

9). Some 5% of the sample reported problems with numeracy ("number work" or "basic maths"), as compared with 10% for literacy ("reading", "writing" and "spelling"); 13% reported what were called problems in basic skills - i.e. literacy or numeracy (or both) - and 2% reported problems in both. Of the 5% reporting problems with numeracy, over a quarter reported "difficulties" in everyday life arising from these problems. Of those reporting difficulties, 32% (or 59 people) reported difficulties at work, 8% getting jobs, and 27% in household management (Hamilton and Stasinopoulos, 1987, p. 20).

Those in manual socio-economic groups had higher proportions reporting problems in basic skills than those in non-manual groups (pp. 25-30) - but these differences may not be reliable indicators of social class differences for the population overall, because many of these 23-year-olds would be likely to change the socio-economic grouping of their work over the course of their careers. In addition, respondents who at age 16 had fathers working in manual occupations or who at age 11 received free school meals, were more likely to have basic skills problems at age 23 (pp. 59-60). School history seems important, too: those reporting basic skills problems had been more frequently absent from school (pp.47-48).

Interestingly, there were no gender differences in reporting numeracy problems. But as Table 2.2 shows, of those reporting problems with numeracy, five times as many men as women had attended classes (10% as against 2%). Reporting numeracy problems was associated with low scores in Mathematics Comprehension at 16, as well as low self-rating in maths at 16 (pp. 50-51). Finally, though having basic skills problems at 23 was associated with low teacher ratings for number ability at 7 (p. 54), having numeracy problems at 23 does not seem to be very much related with teacher's rating on "functional numeracy" at 16.

Many of the results above are as expected, but not all. The last result, though initially surprising, might suggest that the self-report measure, used in this survey, of "problems with number work or basic maths" is perceived by 23-year-old respondents to be about school maths, rather than anything like functional numeracy. Some support is given to this view by Brigid Sewell, in a report on an earlier study with similar focus:

> It seems that while most adults had a reasonable opinion of their own skills, the "maths" that they consciously identified was whatever they happened to find difficult. Many skills are so well absorbed that they used them without recognising it.
>
> (Sewell, 1978; quoted in Withnall et al., 1981, p.7)

On the other hand, the idea that respondents would have interpreted "problems" to relate to school maths, rather than functional numeracy, produces an apparent anomaly concerning the lack of gender differences reported (given the gender differences found in many studies of school maths performance reported in Sec. 2.3). However, it may be that women use what they see as school maths less than men on leaving school, and so see themelves as having fewer "problems". Or it may be that the parts of school maths that are used by adults after school are the parts which women do, or believe themselves to do, with at least as few problems as men; for example, calculations.

The main question about these results thus concerns the reliability of the self-report measure, and the dependability of the main finding - that only 5% have "numeracy" problems. This result can be compared with that for the 16-24 age group for the ACACE study: a 73% average of correct answers (on 11 questions), with the 5th percentile for this age group at only 3 questions correct. This suggests that ALBSU's respondents self-ratings of their numerical skills may have been over-optimistic. Willis (1984) echoes this skepticism: "Can this really be true? Only 1 in 20?"

Willis' solution to the problem of what happened to the 73%

of the 1 in 20 (see the results above) who reported "problems" since leaving school, but which do not now have "difficulties", is that they have devised their "own strategies" for coping with everyday demands (1984, p. 19). But it is clear from the examples he gives (checking change, checking bills, reading timetables) that he is thinking of functional numeracy, and problems with it, rather than problems with school maths.

Some further evidence on functional numeracy is available. The ALBSU itself was quoted during National Numeracy Week in 1983 (Times Educl. Suppl., 9 Sept.), as believing that 1 in 4 adults were not able to calculate change from £5 for 1 item. A few years later, 1 in 4 of a Lancaster University sample of 500 teenagers and 500 adults were reported as unable to work out that thirteen £5 notes made up £65 (The Guardian, 14 May 1987). Both of these seem to be the sort of failing that should qualify as "difficulties in everyday life", but the NCDS data suggest only a little over 1% (27% of 1 in 20) report themselves as having "difficulties". This seems to suggest that the functional numeracy tasks used in these more recent surveys are being carried out under somewhat special conditions - or else that respondents making self-reports to the NCDS lacked self-awareness. Or else that self-ratings were being made on the basis of so many different perceptions of what are "problems", "difficulties", and especially "number work" and "basic maths", that it makes little sense to aggregate what seem to be the "same" responses, until it is established what different respondents mean by these terms. This would require further investigation, using a methodology that would allow the respondents to describe what they mean by problems with "number work" or "basic maths".

2.3 Mathematics Performance and Social Difference: Review of Selected Literature

The surveys reviewed in the previous section suggested that gender, social class and age differences were related to differences in numeracy as measured. Here I review the literatures on such differences in mathematics performance - with the following aims:

- to build up the basis of a "conceptual map" which would summarise a set of plausible explanatory factors for differences in numeracy and mathematical performance, to be used to design the questionnaire in Ch.4 and to focus the analysis of results in Chs. 5 and 6; and, in addition,
- to note how the problem of "differences in performance" is posed in particular contexts;
- to produce suggestions for methods, and for indicators for concepts included in the conceptual map;
- to summarise findings produced in previous work that might be replicated, or challenged, in my research; and
- to note gaps in previous work.

At the time that I was reviewing this literature, and indeed when I was designing the questionnaire, I was working with a view of numeracy very much like that I have called N1 (or N1g), and I was attempting to make a distinction between abstract or school maths (SM) and what I called "practical" (or functional) maths (PM). At the same time, I was aiming to build up explanations that might serve both for differences in school maths performance - <u>and</u> for those in practical maths performance, or "numeracy".

The literature on academic achievement and social class, and that on achievement and gender, tend to be somewhat disparate, with a concern about social class perhaps predominating in the 1950s and '60s, at least in Britain. However, a concern with gender differences, especially in maths and science education, was in the ascendancy in the late 1970s and '80s. Since that time, one of the most vibrant areas in mathematics education research has been that concerned with gender differences. I begin there.

2.3.1 Gender Differences in Mathematics Performance

As indicated above, the literature on gender differences in school maths performance has a good deal of relevance to my concerns here. However, for reasons of space, I decided to give only a summary of the review in the main part of the thesis, and to put the full literature review as prepared in APPENDIX V1.

It is useful to consider North American and British research on gender differences together, although we must note the different institutional and cultural contexts. One difference seems to be that the North American research is more concerned with recruitment to mathematical and scientific careers (e.g. Chipman and Wilson, 1985, p.327), whereas the British maintains a strong concern with differences in school performance; this is perhaps related to an earlier British concern with social class differences in secondary school selection and performance (see next subsection).

The main focus of the US research was at first on group differences in performance in standardised national tests, such as the first International Study of Achievement in Mathematics (1964), or the more recent waves of the National Assessment of Educational Progress (NAEP). However, early on, Elizabeth Fennema, one of the main researchers in this area, emphasised that the gender differences reported from these studies ignored that males had studied more maths at school, and also the fact that "the single most important influence on learning mathematics is studying mathematics." (Fennema, 1979, p.391)

This led to attempts to control for "participation", or the number of maths courses studied, in subsequent studies (e.g Fennema and Sherman, 1977). Indeed, low female participation in mathematics, even more than low female achievement, was the focus of the large-scale research programme on women and mathematics, funded by the U.S. National Institute of Education in the late 1970s (see APPENDIX V1 and Chipman, Brush and Wilson, 1985).

A number of studies in the UK, e.g. those of the Assessment of Performance Unit (APU), have also found gender differences in school mathematics performance in favour of boys among 15 or 16-year-olds, and sometimes among 10 or 11-year-olds - though this claim for the younger age groups was certainly challenged (NOTE 11). However, these results have also been disputed generally, for example by Walden and Walkerdine (1985), using several types of evidence (see APPENDIX V1). They questioned the "reification of the categories 'girl' and 'boy' [which] help to produce explanations which favour sex-specific characteristics" (1985, p.23), and themselves turned their attention to the way girls' good performance was discounted in classrooms - e.g. by the tendency for girls to be entered less often than boys for the higher status, more "demanding" examinations, i.e. GCE O levels (rather than CSE's), and A levels (1985, pp.44-45). (See further Sec.7.5 below and Walkerdine et al., 1989.)

Turning to higher education, in the UK, women are still under-represented in gaining first degrees in maths, and even more so for doctorates. The imbalance appears to be improving slowly over time, but the level of female participation at this level is behind that in the USA. (NOTE 12). Yet the majority of student places on mathematics courses in higher education are likely to be taken by non-maths specialists. (NOTE 13) In both countries, there is a dearth of information on gender (and other) differences in performance on maths courses, and in mathematics "preparation", by such students. However, Chipman and Thomas cite evidence from a study (Dunteman et al, 1979) which indicates that women in the social sciences and life sciences were somewhat less well prepared in mathematics than men in those fields (1985, p.19). Another gap in our knowledge concerns the question of how important mathematical knowledge is for people in non-technical fields, or for general citizenship (1985, pp.18-19).

At this point, it is convenient to consider explanations for differences in school maths performance. One of the most important for the argument here comes from Fennema and her colleagues. Since the late 1970s, they have developed their model from one that aimed to explain gender differences in school maths outcomes (Fennema and Peterson, 1985), to one aiming to explain differences in these outcomes as having more general bases (Fennema, 1989). Here, I discuss the most recent "generic" model; see Fig. 2.1 (p.463; NOTE 9).

There are a number of points to note about this model. First, variables such as innate "abilites" are omitted - on the grounds that "the examination of biological variables, which are often believed to be unchangeable, would not offer much help in achieving equity in education" (Fennema et al., 1985, p.304). (NOTE 14) Second, "external" factors are seen as having an influence on affect and, through "mediating learning activities", on outcomes like performance. Third, external factors are apparently _social_, whereas the others are "internalised", or are accomplished, by the _individual_. The idea of learning activities mediating between social and affective variables, on the one hand, and performance, etc. on the other, is based on the earlier idea of "autonomous learning behaviors", which include actions such as choosing to solve a novel problem, "thinking independently", and persisting (Fennema and Peterson, 1985). (Further discussion of these latter developments is beyond the scope of this part of the thesis.)

The literature review reported in APPENDIX V1, and the others to be discussed in this chapter and the next supported my initial emphasis (Ch.1) on _affective_ variables as explanatory of differences in maths performance at school. Specific affective variables are discussed in Ch.3.

Social variables here are understood to include the influence of home, community and especially the school. (A brief review of the scope of variables in this category is given in APPENDIX V1.) In considering empirical research, the issue arises of how to measure these sorts of social variables. In several of the theories indicated in APPENDIX V1, the school and the home are considered to exert an influence on the individual student through _others_' aspirations, expectations, beliefs and attitudes - especially those of teachers and parents - and through the student's perception of these (e.g. Chipman and Wilson, p.304; see also Sec.3.1). But although variables such as teacher's, mother's and father's attitudes to the student as a learner of mathematics were included in Fennema and Sherman's Mathematics Attitude Scales (see Sec. 3.3), for example, and showed correlations with outcome measures, it is not clear how the complexity of these others' attitudes can be captured even by 10 or 12 attitude items, nor exactly how their effectivity is meant to operate. There are also the problems of the accuracy, and the depth, of the student's perceptions of these others' attitudes. These are serious problems for approaches which aim to study the effects of others' views, using methodologies based on questionnaires.

The effect of family aspirations, beliefs, etc., as well as that of peer pressures, would be better investigated by less structured interviews with the student - or, preferably, by less structured interviews with "significant others", such as parents. Other effects, such as teacher actions and classroom processes, would preferably require a range of methods, including participant observation. The latter were ruled out as impractical in the early stages of this study, but the former, viz. less structured interviews with the students, are the main method used in the second part of the study (see Ch.9). The effects of cultural beliefs or, better, "discourses" shaping particular beliefs, e.g. those which might put particular students into contradictory positions about doing well in maths, are discussed more fully in sec. 3.2.4 and in Sec. 7.5.

To summarise, the literature review of gender differences in academic maths performance has emphasised the relevance of affective and social variables in a generic model, and the importance of controllng for the number of maths courses taken, for US studies at least. However, differences in the number of years of mathematics studied is not a promising basis for explaining any gender differences there may be among school pupils in test performance in the UK - unlike the USA - since almost everyone studies maths up to 16. Nevertheless, for a study of adults, controls on the amount and content (e.g. O-level or CSE stream for those at school before the mid-1980s) of maths previously studied may well be important. Some of the gaps indicated above - in terms of information on the level of maths course preparation for non-mathematical degree study, and on the needs for "mathematical" knowledge in fields such as the social sciences, as well as in everyday life - point to questions that could be investigated in the present study.

This review will be used, along with the rest of this chapter and the next, to develop a conceptual map underlying the hypotheses to be investigated and to design the questionnaire to be used in the survey (see Ch.4).

2.3.2 Social class differences in mathematics performance

This review of the literature on social class is somewhat different to that on gender in the previous subsection for at least two reasons. First, social class differences have not had as much attention as gender in recent research in mathematics education - and this is a lack that I would argue needs making good. Second, much of the aim here is to clarify the notion of social class to be used, and to decide on which indicators to use both in the questionnaire and in the interviews, in addition to summarising relevant findings.

The literature on social class differences in educational performance is immense. I begin by considering three reviews, by Reid (1981), White (1982), and Reyes and Stanic (1988) in the fields of sociology, psychology, and mathematics education, respectively.

In a book that is basically a review of empirical research, Reid defines social class as "a grouping of people into categories on the basis of occupation" (1981, p.6), since "occupation is a good indicator of the economic situation of a person and a family" (p.7; my emphasis). He summarises many well-known results on social class and education for the UK; the indicator for social class here has usually been the Registrar General's occupational class categories (I, II, III Non-manual (NM), III Manual (M), IV, and V), or socio-economic groups (see Reid, Ch.2). One of the problems of measurement has to do with the unit of measurement: when an indicator for the family's social class has been needed, the work reviewed by Reid has usually used the occupation of the father, as "head of household".

White (1982) reviews almost 200 studies, mainly North American, of the relationship between socio-economic status (SES) and academic achievement. He starts from a definition of SES as: "the position that an individual or a family occupies with reference to the prevailing standards of cultural possessions, effective income, material possessions and participation in group activity in the community". According to White, the most frequently used indicators of SES are occupation, education, and income (of the head of household, where appropriate), but he feels there is a worrying proliferation of other indicators which are sometimes used (pp.462-63). White argues that measures of home atmosphere / child rearing - whether parents read to children, take them to the library, help with homework, and encourage them in school - often have a higher correlation with student achievement than SES measures do; we could say that these indicators are more genuinely cultural. (NOTE 15)

Reyes and Stanic's (1988) review discusses fewer studies: this suggests that not many recent studies in mathematics education have used social class or socio-economic status, and the review gives the impression that those that have included SES are difficult to reconcile because of the use of differing indicators. Further, particular studies are marred by the problems of proxy measurement (questions being addressed, not to the parents themselves, but to the students, acting as "proxies") or by highly aggregated levels of analysis: correlations based on aggregated units, such as the classroom, the school or the area, tend to be larger, often substantially so. However, the re-analysis by Welch et al. (1982) of the 2nd National Assesment of Educational Progress (NAEP) mathematics study suggests that SES or social class might be an important predictor for mathematics performance, in the American context at least. (NOTE 15a)

Some of the work reviewed in the previous subsection (and in APPENDIX V1) does consider SES as well as gender. Brush (1985) found that socioeconomic status was a significant predictor of participation for girls, but not for boys; she used father's occupation as an indicator for SES. Armstrong (1980), similarly, found greater correlations of participation and performance with SES for young women than for young men, for most of the "components" of SES - father's education, mother's education, and father's occupation (participation only) - but not for mother's occupation. Thus it seems that there may be an "interaction" effect for gender and social class for participation at least, at least where father's occupation is the indicator for SES.

In the UK, the NCDS (see sec. 2.2.2) included social class in its conceptual map, and used the Registrar General's occupational classes (see above) as the indicator; for most analyses, these were collapsed into three groupings: non-manual, classes IIIM and IV (skilled / semi-skilled manual), and class V (unskilled manual). They found substantial differences between these groupings in a standardised mathematics test at age 16, which represented a widening of differences found at ages 7 and 11. In the APU studies, an indicator for social class was available only at the school level in the form of the proportion of pupils on free school meals - up to 16%, 16% to 35%, and more that 35%. Typical results showed a decrease in performance as the proportion of pupils on free school meals increases (Foxman et al., 1985).

Marsh (1988) offers several recommendations based on her surveys of the unemployed - which are relevant here, because they raise similar issues to studies using full-time adult students many of whom have previously done paid work:

- <u>not</u> abandoning occupation-based measures, despite the respondents' not currently having a job;
- collecting information about the last main job, and when it was finished; and
- using interviewer-administered measures, not the respondent's self-categorisation.

So what can this literature review suggest about the following issues:

- the idea of social class to be used in the study?
- the choice of indicator? and
- the appropriate unit of measurement?.

Most of the research reviewed above is survey research, using questionnaires, and it has generally been based on conceptions of social class which are what might be called <u>economic</u>, and which often are concerned with <u>cultural</u> facets of class positions as well. A notion of social class as having even economic and cultural aspects suggests a multi-dimensional concept (see e.g. Goldthorpe, 1988), and would require a number of questions to be used in the questionnaire. Parental occupation (or occupation of head of household) is the most frequently used indicator for social class in the UK, often as a single dimension. As for parental education, and parental income, the other two indicators most used for SES, neither provides a more obviously valid single dimension; further, income questions are not much used in the UK because of respondents' resistance to respond, and parental education questions can meet problems of recall (or not knowing), if posed to members of the family other than the parents themselves.

In practice, because of the constraints on any questionnaire envisaged for this study - namely, a short time available for administration, and the likely need for self-completion - it was realised that it would not be possible to ask sufficient questions to produce multiple dimensions. Thus I resolved to use an occupational classification as my indicator of social class for the questionnaire. It seemed useful in the light of ideas above to ask the occupation of both parents, and also the last occupation of the student him/herself (where appropriate) before joining the course. These decisions are taken up in Ch.4 in the discussion of indicators.

If we consider the type of conception that might be appropriate to use in the interview, we can note that the ideas of Walkerdine et al. (1989) about social class include both economic features - such as access to wealth, living standards and orientation to money, and cultural ones - such as attitudes to work and to education, and beliefs about what can be known and how you know it. And since this study is also concerned with affective issues, we might also allow space in our conception of social class for differences in what we might call identity - such as the meanings of "growing up" and attaining "independence", and ways of manifesting anxiety or exercising power. These ideas are taken up in the discussion of the interviews in Chapters 9 to 11.

2.3.3 Age Differences

Age differences are not usually seen as problematical in school studies of mathematical performance. (NOTE 16) However, in studies of adults in higher education for example, age differences between traditional entrants to higher education in late adolescence (18 to 20) and "mature" (21+, and especially 25+) entrants may well be relevant.

There is not a great deal of research on adults and mathematical performance; what there is tends to be based on students in tertiary institutions, and to focus on gender differences and those to do with amount of maths course preparation, rather more than age differences; see Sec. 3.3. However, there are several features of the position and experiences of older adults that may affect their performances on maths tests. First, since they tend to have left full-time education a longer time ago, there is a greater possibility that remembered knowledge and also study skills have "decayed", and hence that capacity for academic performance has declined; this is even more likely in subjects such as school maths - especially if the person sees it as "nothing to do with real life". Second, it appears that short-term memory, which is important for scanning and interpreting incoming information, is more easily disrupted in older people - and hence learning and performance under time pressure are likely to be more difficult for them: they may become confused and make mistakes (Rogers, 1971, p.53). This may in turn mean that older adults may be more anxious, and less confident, especially about testing.

2.4 Summary

In this chapter, I have developed the idea of numeracy by distinguishing two basic ways of conceiving of it:
N0 - numeracy as a set of abstract basic skills, largely to do with arithmetic calculation, which are assumed to be applicable in a range of practical contexts; and
N1 - numeracy as a set of skills, which are seen as more practical, in that their selection, definition and measurement is dependent, at least to some extent, on a context, which is often described simply as "practical", or out-of-school, or "everyday life".
N1 may itself be divided into a view which considers that the set of skills can be generally defined, N1g, and one which insists on a definition by a particular individual of the skills which are "relevant", N1p.

A conception of numeracy is necessarily linked with understandings about the meaning and importance of the context of numerical work, and about the possibilities of "transfer" to practical contexts of ideas and skills learned in school. NO is based on the view that mathematical skills are context-independent: if they are learned and understood properly in abstract, then it is in principle straightforward to "transfer" or apply them in a range of contexts. The capabilities comprising N1, on the other hand, are seen as somewhat more grounded in a context, which is named - or which is specified by a list of needs related to the context, e.g. "everyday life" as discussed in Cockcroft. The notion of straightforwardly "transferable" skills becomes more problematical in N1. A number of different contexts have been distinguished in the work reviewed: school mathematics; other subjects (for school or college pupils); and "everyday" or practical activities. Within the practical category, various work contexts may be distinguished from "other everyday" ones, such as shopping. What the APU calls the "money" context is seen as more or less familiar to all pupils - and hence to all adults.

We can distinguish more clearly among the three basic views of numeracy so far developed, by envisaging the type of numeracy test each would recommend. Those holding a NO view would likely present a set of abstract sums to complete; this sort of test is common at many job interviews, and sometimes even as an admission test for higher education. The N1g view would present a set of items "in context", through suitable wording, as in the ACACE survey discussed in Section 2.2. For N1p, the concern with variations in individual activity, and hence in numeracy needs, tends to lead to using self-report measures, as in the ALBSU / NCDS survey also reported above.

The questions used in the ACACE survey for Cockcroft (1982) (and in the Basic Skillls Accreditation Initiative (BSAI, 1990)) were deemed to be especially useful for studying numeracy. In contrast, the self-report indicator used in the ALBSU / NCDS study was considered problematical. The results of the ACACE study showed gender differences in performance in favour of men, social class differences with AB (professional and managerial) occupations doing best and DE (less skilled manual) least well, and age differences in favour of younger (especially 25-34 year old) respondents.

Part of my aim in this chapter has been to begin to produce explanations of how numeracy is developed. The results from the ACACE study suggest that differences of gender, social class and age are related to differences in numeracy or "practical maths" (PM) performance. It should be noted that, in the first half of this thesis, I use numeracy and practical mathematics interchangeably. I also sought to build up explanations for differences in school maths (SM) performance. Here the available literature is much more extensive. Gender differences are found in many studies of mathematics performance, but they have been found to depend on differences in numbers of maths courses taken (and also on the content of the test items). Social class differences have been found in many studies of educational attainment, especially in the UK, though less so in maths education research - partly because the concept has been less used in recent studies in this field. There is little research on age differences in mathematical performance, but these might be expected, particularly in adult populations displaying a relatively wide age range. Thus these literature reviews provide a good basis for expecting performance differences both in numeracy and in school mathematics to relate to gender, social class and age differences.

The mathematics education literature also points to the influences of affective variables, and of "social" factors. Social factors here are understood to include the influence of home, community and especially school. However, the relevance of these variables is limited for the present study for several rasons. First, I have argued that there would be difficulties in producing valid measures for certain of the variables using questionnaire items. Second, I had doubts about the relevance of school variables in particular for explaining differences in numeracy, as well as differences in school maths performance. Third, as illustrated by the literature review, the social covers a very broad and diffuse area - whereas emphasising the affective would allow me to focus on a more specific area where there seemed to be more agreement on the variables of interest and on appropriate indicators (see the next chapter for further details). (NOTE 17) Moreover, the importance of affect - for example, feelings of confidence - has been indicated, both for numeracy and for school maths performance.

Despite the differences sketched between them, there is a major similarity between NO and N1. Both largely accept the idea that the mathematical content of a problem and its practical context can be separated. Put another way, the mathematical content of a school problem, and that of a shopping problem, can be "the same". In contrast, at one or two points in this chapter, there has been a hint of a view that there might be a discontinuity between school maths and the numerate ideas and skills used in shopping, say - or indeed between the numerate aspects of shopping and those of playing bridge; this alternative view, which could be called "N2", stresses the specificity of numeracy-in-context, or numeracy in practice. (This in turn raises other questions: how to describe the context of numeracy, and also the possibility that a task or question may be based, or be perceived as being based, in more that one context at once. These issues anticipate fuller discussions in Ch.7.)

In this chapter, I have argued that gender, social class and age differences are related to differences in performance both in numeracy (or practical maths) and in school mathematics. I have also suggested that affective variables such as confidence are likely to be related to mathematical and numerate performance. In Chapter 3, I consider issues concerning affect more fully. This will allow me to discuss the conceptual map, which is the basis for the quantitative part of the research, in Ch. 4.

CHAPTER 3 : AFFECT, ANXIETY AND MATHEMATICS ANXIETY

> QUESTION: What do you dread as you open your eyes in the morning?
> ANSWER: That I'm still at school and it's double maths.
> (Shona MacDonald, aged 26, a promotions manager, interviewed in City Limits, 23-30 May 1991)

In this chapter, I begin (in Sec. 3.1) by reviewing briefly the range of affective factors discussed in recent years in mathematics education - from the feelings of confidence mentioned most often in Ch.2, to those of anxiety and mathematics anxiety, in particular. However, it is necessary to restrict the affective variables included in the conceptual map underlying the questionnaire, and so I justify focussing on anxiety and mathematics anxiety in this thesis. I then discuss different notions of anxiety (in Sec.3.2) and maths anxiety (in Sec.3.3) as they have developed since the late 1940s, some of the principal attempts to measure them, and some pertinent research results - especially on the relationship between anxiety and performance, and on gender, social class and age differences. In addition, given that I have aimed to deal with the issue of the context of cognition and performance by distinguishing numeracy or practical mathematics from school mathematics in Ch.2, I consider here whether it might be useful to aim to distinguish two (or more) dimensions of maths anxiety depending on the context.

3.1 Mathematics and Affective Factors

I begin by clarifying the meaning of the main terms used in discussing this area: "affect", "attitude", "belief", "emotion". For Fennema, affect included "feelings, attitudes and values" (1979, p.394), and again "attitudes or affective beliefs held by females, male peers, parents and educators towards females as learners of mathematics" (p.391). For Laurie Hart Reyes,

> affective refers to students' feelings about mathematics, aspects of the classroom, or about themselves as learners of mathematics ... (including) ... general feelings such as liking / disliking of maths ...(and) ... perceptions of the difficulty, usefulness, and appropriateness of maths as a school subject....
>
> (Reyes, 1984, p.558)

Clearly, both of these definitions show some overlap with "attitudes" and "beliefs". Reyes (1989), drawing on psychologists for clarification, quotes Herbert Simon's (1982) distinction among three forms of affect: emotion, wtich can suddenly interrupt the current focus of attention, as in surprise, fear and anger; mood, less acute but nevertheless able to influence cognition (e.g. remembering), as in happiness or sadness; and valuation, which may depend on memories of earlier affect. Simon's characterisation of affect, typical of psychologists, focusses more on "hot", visceral reactions, whereas educational researchers tend to "mean a wide variety of beliefs, attitudes, and emotions ranging from 'hot' to 'cold'". (Reyes, 1989).

Reyes (1989) takes psychologists' definition of an attitude as having three components:
(i) an emotional (affective) reaction to an object;
(ii) a predisposition to behave favourably or unfavourably toward the object; and
(iii) beliefs about the object.
In seeing (some) affect as part of attitudes, this view seems to diverge from Fennema, who sees attitudes as part of affect. Reyes in fact distinguishes a "mathematics education

view" of attitudes as "any of a number of perceptions about mathematics, about oneself, of about one's mother, father or teacher" (1989, p.40), where these perceptions normally lack emotional intensity (and are very much like beliefs). An illustration would be Fennema and Sherman's (1976) Mathematics Attitude Scales (see Sec.3.3).

A belief normally involves a commitment to some sort of factual statement, though it may also involve a commitment to value something (e.g. Cobb, 1986). Schoenfeld (1985) describes belief systems as conceptions about the nature of mathematics, in particular the constitution of mathematical arguments. And Fennema labels (some?) beliefs as "affective". This suggests that it may be difficult to classify beliefs as either simply cognitive or simply affective.

Reyes' concept of emotion is much like Simon's (above): it is normally of a higher intensity than say, an attitude, and it may be categorised as positive or negative. Thus anxiety tends to be seen by psychologists as a "hot" emotion, although some maths educators (e.g. Fennema and Sherman (1976) in their original Mathematics Attitude Scales) treat maths anxiety more like an attitude, a less intense reaction.

To sum up, the view which I shall adopt is that the affective is only one component of a typical attitude, but many expressions of affect would not be seen as part of an "attitude" - especially expressions of emotion, which is seen as higher in intensity and shorter in duration. However, though they do not mean the same thing, much discussion of affect in the literature overlaps with that on attitudes. Because of my interest in relating the cognitive and the affective, I focus on affect in this thesis.

Various affective components have been highlighted by most American and British work. Fennema (1979) mentions :

- the confidence - anxiety dimension;
- perceived usefulness of mathematics;

- liking and enjoyment of maths; and
- perceived difficulty of maths.

Reyes (1984) focusses her review on confidence, maths anxiety, perceived usefulness, and attributions of success and failure (see APPENDIX V1). Brush (1985) proposed a further dimension "creative / dull".

A slightly wider range of affective factors are discussed in the literature reviewed by Bell et al.(1984, Ch.9) for Cockcroft :

- maths anxiety;
- finding maths useful or "of social benefit";
- liking / enjoying maths;
- finding maths difficult.

But they also mention in addition:

- finding maths interesting; and
- whether maths allowed "freedom".

These findings again are based mainly on school pupils, as are those to do with perceptions or beliefs about maths, e.g. as either "mechanical" or "intuitive".

The Assessment of Performance Unit (Foxman et al., 1985; Joffe and Foxman 1986) asked pupils to indicate their degree of agreement with a series of statements on a 5-point scale (NOTE 1), and then used factor analysis to produce three dimensions of attitudes towards mathematics: enjoyment (or liking) of mathematics; perceived usefulness; and perceived difficulty. At age 11, enjoyment was an important influence on attitudes, but by age 15, usefulness seemed to override it (1985, p.470). When pupils were asked to rate the difficulty of particular items, and this rating was compared with the actual performance, it appeared that some pupils, especially boys, underestimated the difficulty - whereas others, especially girls, still expressed doubts about their performance though it had been correct, or attributed their success to luck (1986, pp.42-43). We could interpret this as "overconfidence" on the part of boys and "diffidence" in girls.

To summarise, there is a substantial measure of agreement about the affective variables that might be expected to influence thinking and performance in mathematics in older students and adults. These are:

- the confidence - anxiety dimension;
- perceived usefulness of mathematics;
- perceived difficulty of maths; and
- finding maths interesting.

All of these will be included in the conceptual map, to be developed in Ch.4.

Two different types of models have been proposed as a basis for relationships between affective variables and cognitive performance in mathematics tests and problem-solving. The first can be exemplified by Fennema's (1989) "generic model", already discussed in sec.2.3.1; there "external" / social variables influence both affect and "mediating learning activities" which in turn influence cognitive outcomes like performance; see Fig. 2.1. (NOTE 2)

There are advantages and disadvantages in using such a model. It can be made comprehensive by including both the range of affective factors mentioned above - and a range of social and cultural variables as well. On the other hand, the nature and operation of the many social influences is unclear. For example, the attempt to include the "cultural milieu" through taking account of "socializers'" aspirations, expectations, etc. and through the students' perception of these (Chipman and Wilson, 1985, p.304) raises a range of problems to do with conceptualising these "influences" and measuring them (see Sec. 2.3.1).

An alternative model is used as the basis of a recent symposium on <u>Affect and Mathematical Problem Solving</u> (McLeod and Adams, 1989). Drawing on the ideas of Mandler (e.g. 1989a - see also McLeod, 1989a), the contributions here are based on the following theory (called "cognitive-constructivist"):

(i) a discrepancy (or interruption) between the student's expectations and the demands of ongoing activity leads to visceral arousal;

(ii) the physiological arousal, on the one hand, and the person's evaluation of the situation, on the other, lead to the "construction" of emotion; and
(iii) emotion may lead to a reduction in the conscious capacity available for problem-solving.

Mandler (1989a) argues for this theory by distinguishing "macroanalytic" and "microanalytic" approaches: macro approaches typically produce overall measures of individual "characteristics" (assumed to be relatively stable), such as "maths test anxiety" and "performance on number facts"; micro approaches focus on the process of what happens in a specific interaction of an individual and a particular task. Thus, although questionnaire measures are perhaps appropriate for the measurement of repeated emotional reactions to a category of (say, mathematical) tasks, more process-sensitive methods would be necessary for describing reactions which are not yet so automatised (McLeod, 1989b).

The advantages of this theory are its relative parsimony, and the relative clarity of the operation of its effects. On the other hand, it is focussed purely at the individual level, and it does not seem to leave a space for social or cultural effects. However, Mandler (1989b) warns that the cultural transmission referred to in the "differential" models discussed above is much less straightforward than it might seem: the application of values is very context-specific, dependent both on the other persons involved, and how the situation is perceived; for example, children do not apply their parents' values indiscriminantly.

Thus it seems that these two different models offer competing advantages and disadvantages, depending on the types of affect and cognition we wish to study. McLeod (1989a) distinguishes several dimensions of variation in affect:
(i) intensity;
(ii) direction (positive vs. negative);
(iii) duration;

(iv) the level of awareness (which may depend on available processing capacity or attention); and
(v) the level of control.
The first three of these dimensions can clearly be useful in distinguishing the different types of affect discussed so far. Thus, frustration and anxiety are strong and negative, satisfaction and joy are stong and positive, with liking less intense. The third dimension, duration, distinguishes emotion (transitory) from attitudes (stable); it might also be seen as related to the distinction of state vs. trait anxiety (see Sec. 3.2).

3.1.1 Confidence and anxiety

As well as featuring strongly in the literature reviews just cited, "confidence" is highlighted in the discussions of numeracy, by Cockcroft and others, in Ch.2. Given my experience with the adults I have taught I certainly was attracted to the idea of confidence, and anxiety too, as powerful, and opposite, influences in learning. For these reasons I resolved early on to focus my interest in affective factors on confidence and anxiety.

As I continued my literature review, I was struck by how well developed was the literature on anxiety (see Sec.3.2), and on maths anxiety (Sec. 3.3), as used both by researchers and by those concerned with intervention programmes. Also I became aware that at least two pencil-and-paper tests, the Fennema - Sherman Mathematics Anxiety Scale, one of a set of nine "attitude" scales, and the Richardson - Suinn Mathematics Anxiety Rating Scale (MARS), had been developed, and were widely used in research and in intervention in North America (see sec. 3.3.1).

Rather more studies recently have used maths anxiety as a concept, and relatively few have used "confidence". Fennema and Sherman (1976), on the other hand, used a measure of both in their battery of scales for attitudes towards mathematics. Because they reported a high negative correlation (r =-0.89) between confidence and anxiety, and because confidence was more highly correlated with performance than any other affective variable (r =.40) (1979, p.395), the work of Fennema and her colleagues has subsequently used confidence, rather than maths anxiety, as an affective variable. (NOTE 3)

Therefore, for all these reasons - the extensive literature on anxiety and maths anxiety, the availability of at least two scales for measuring maths anxiety, and my interest in intervention programmes for adults with difficulties in maths - I gave priority in my conceptual map to maths anxiety scales over the other affective variables, though confidence and several other variables were also included (see Sec. 4.1).

3.2 Psychology and Anxiety

The study of anxiety within the discipline of psychology is widely agreed (e.g. Biggs,1962,p.59; Spielberger, 1972a) to have its basis in the work of Freud, though his ideas were only partially applied in psychological theories of anxiety; see the next subsection. Nevertheless, anxiety has certainly come into its own in psychology since World War II: Spielberger (1972a) estimated that between 1950 and 1970 over 5000 articles or books on it were published.

I begin by tracing the emergence of the concept of anxiety, and how its meanings and uses have developed and changed.

3.2.1 Conceptions of Anxiety

Freud's views on anxiety will only be introduced here: though his name is often invoked, some critical aspects of his theory are not fully taken up by most post-War work in psychology. Freud proposed a characterisation of anxiety as: motor "innervations" or "discharges", a perception of these, and feelings of unpleasure. He distinguished between "realistic" (normal), and "neurotic" anxiety. The former he considered a reaction to the perception of an external danger; the prototype experience was the birth trauma. Neurotic anxiety itself could take two forms: "expectant" anxiety which is free-floating, and phobias, attached to particular objects or situations (Freud, 1916-17/1974, pp.443-448). (NOTE 4)

Because anxiety is "unpleasant", there is a tendency for it, or for the ideas associated with it, to be repressed, to be pushed into the unconscious. But repression does not destroy these contents; rather, they retain their charge, but undergo a transformation. If they come back to consciousness, they tend to be found in a disguised or distorted form. In "normal" people, repressed material returns as jokes or slips of the tongue, or in dreams. (Otherwise, it may return as neurosis or illness.)

In his work on dreams, Freud (e.g.1900/1965) distinguished the manifest from the latent content. The manifest content is the dream as it originally appears to the dreamer, whereas the latent content is the group of meanings - including unconscious meanings - revealed at the completion of the analysis of the dream. By extension, we can speak of the manifest content of any verbal product - from fantasies to interview text or literary works - which we intend to interpret using the analytic method. (Laplanche and Pontalis, 1973, pp. 235 & 243). Thus a "manifest" expression of no anxiety, or even great confidence in an interview may actually indicate anxiety.

Since in the psychoanalytic view anxiety may be unconscious, it therefore cannot be assumed to be observable, let alone quantifiable. Only certain of its symptoms may be observable, and because of defences, these may appear in distorted form: as "no feeling" at all - or indeed as the opposite of anxiety. Freud therefore postulated the use of defense mechanisms such as repression, or "reversal into the opposite". The implications of these aspects of Freud's thinking will be taken up in Ch.8.

Despite Freud's distinction between manifest and latent content, post-World War II work in psychology almost invariably assumed that anxiety was observable - marked by the behaviourists' naming their first self-report scale the "Manifest Anxiety Scale" (MAS, see next section) - and quantifiable. This was related to developments in psychology, particularly aspirations to be "scientific". However, this did not solve all the theoretical problems. Indeed, it led to a period of great controversy in anxiety research; see APPENDIX V3.

There were a variety of responses to the controversies from psychologists. Spielberger, in a publication resulting from a conference designed to bring these opposing views into confrontation, offered a psychological definition of anxiety as

> a palpable but transitory emotional state or condition characterised by feelings of tension and apprehension and heightened autonomic nervous system activity
> (Spielberger, 1972b, p.24)

It can be seen that this definition aims to take into account the three aspects stressed by Freud - unpleasant feelings, discharge (physiological or behavioural), and a perception of these - but it still sees anxiety as "manifest". Spielberger's contribution was to develop the distinction between measures of one's transitory emotional state of anxiety, called the <u>A-state</u>, and relatively stable individual differences in being anxiety-prone, called the <u>A-Trait</u> (Spielberger, 1972b; Spielberger et al, 1970).

The development of "cognitive" approaches within psychology led to a cognitive approach to anxiety (e.g. Beck and Emery, 1985). A distinction between two components of test anxiety was made early on:
<u>worry</u> or "lack of confidence" was seen as <u>cognitive</u> concern about test performance, the consequences of failure, the

ability of others relative to one's own, etc.; and <u>emotionality</u> was conceptualised as physiological / autonomic <u>arousal</u>, reflecting the immediate uncertainty of the test-taking situation. (Liebert and Morris, 1967, p.975.) (NOTE 5)

Overall, by the beginning of the 1970s, to a great extent, "anxiety" had been allowed to slip into meaning "manifest" or expressed anxiety, and failure to report anxiety was usually taken to mean "no anxiety". In psychology, the lessons of Freud for understanding anxiety had been largely forgotten.

3.2.2 Measures of Anxiety

In his discussion of what we have seen are more or less conscious forms of anxiety, Spielberger makes a distinction between physiological and behavioural aspects of anxiety and what he calls "phenomenological/experiential" aspects. He points out that because of the complexity of the phenomenon, investigators have tended to emphasise one or other aspect, and therefore a particular type of indicator (1972b, p.25).

In my view, indicators for anxiety can be divided into four types. Thus, <u>physiological</u> indicators for anxiety include:
(i) heartrate, blood pressure, or respiration rate;
(ii) galvanic skin response (GSR);
(iii) muscle tension (Stennett, 1957, cited in Levitt, 1968); and
(iv)"cortical potentials" in the brain (EEG). (For others, see Beck and Emery, 1985). (NOTE 6)

<u>Behavioural</u> indicators of anxiety include: flight, "freezing", restlessness, speech that is dysfluent or "abnormally fast" or "abnormally slow". (For others, see Beck and Emery, 1985).

<u>Clinical</u> indicators include "projective" measures like the Thematic Aperception Test (TAT), and the Rorschach Test,

both of which attempt to elicit fantasy material, and to interpret it. A variant of the TAT has been used in the rating of "achievement motivation" - "nAch" (McClelland et al., 1976; Horner, 1968).

Self-report questionnaires have been the most often used type of measure, because of their convenience. Probably the most used have been Taylor's (1953) Manifest Anxiety Scale (MAS); Sarason et al.'s Test Anxiety Questionnaire (Mandler and Sarason, 1952), which soon was produced in a children's version (Sarason et al., 1958a); and Spielberger's State - Trait Anxiety Inventory (STAI; Spielberger et al., 1970), and Test Anxiety Inventory.

Occasionally, there have been attempts to combine self-report and physiological indicators (e.g. Stennett, 1957; Dew et al., 1984). Also Sarason et al. (1958b) used results of the Rorschach test, as well as self-report. Let us consider the advantages and disadvantages of each type of indicator in turn.

First, physiological measures. They claim to be "objective", in the sense that they can measure aspects of the emotion directly, without depending on the report of the subject, or on the interpetation of researcher or clinician. And in principle they can be measured concurrently, while the subject is engaged in another activity. The disadvantage of this direct measurement is that there are broad individual differences in Autonomic Nervous System reaction to emotion, so that the same quantitative reading may mean different things for different people. And, of course, a given physiological reading, such as heart rate or GSR, may not be indicative of anxiety, rather than another emotion: an emotional state is specific only at the subjective level (Cannon, 1929). Such measurements are also obtrusive and expensive to take, and group administration is difficult.

Behavioural measures are also publicly observable, and the subject may be questioned as to their meaning. But they rely on knowing a baseline of the subject's "usual" or "normal" behaviour, and the particular behavioural "quirks" that indicate anxiety may very from person to person.

With projective measures, it is more difficult for the subject to "fake good" and these measures have the potential to tap unconscious emotions, which other types of measures are likely to miss. However these methods require trained staff to use them, and, even with such staff available, the results may be difficult to interpret. The results therefore may have relatively low reliability, and they may be difficult to quantify. However, this is not necessarily so: one projective measure, nAch (see APPENDIX V3), came to have good inter-scorer reliability (e.g. Horner, 1968), because of rigorous standardisation of procedures (and a comprehensive manual), though its test-retest reliability was less good (Sneddon, personal communication). If projective tests are administered to large groups, considerable resources will be required.

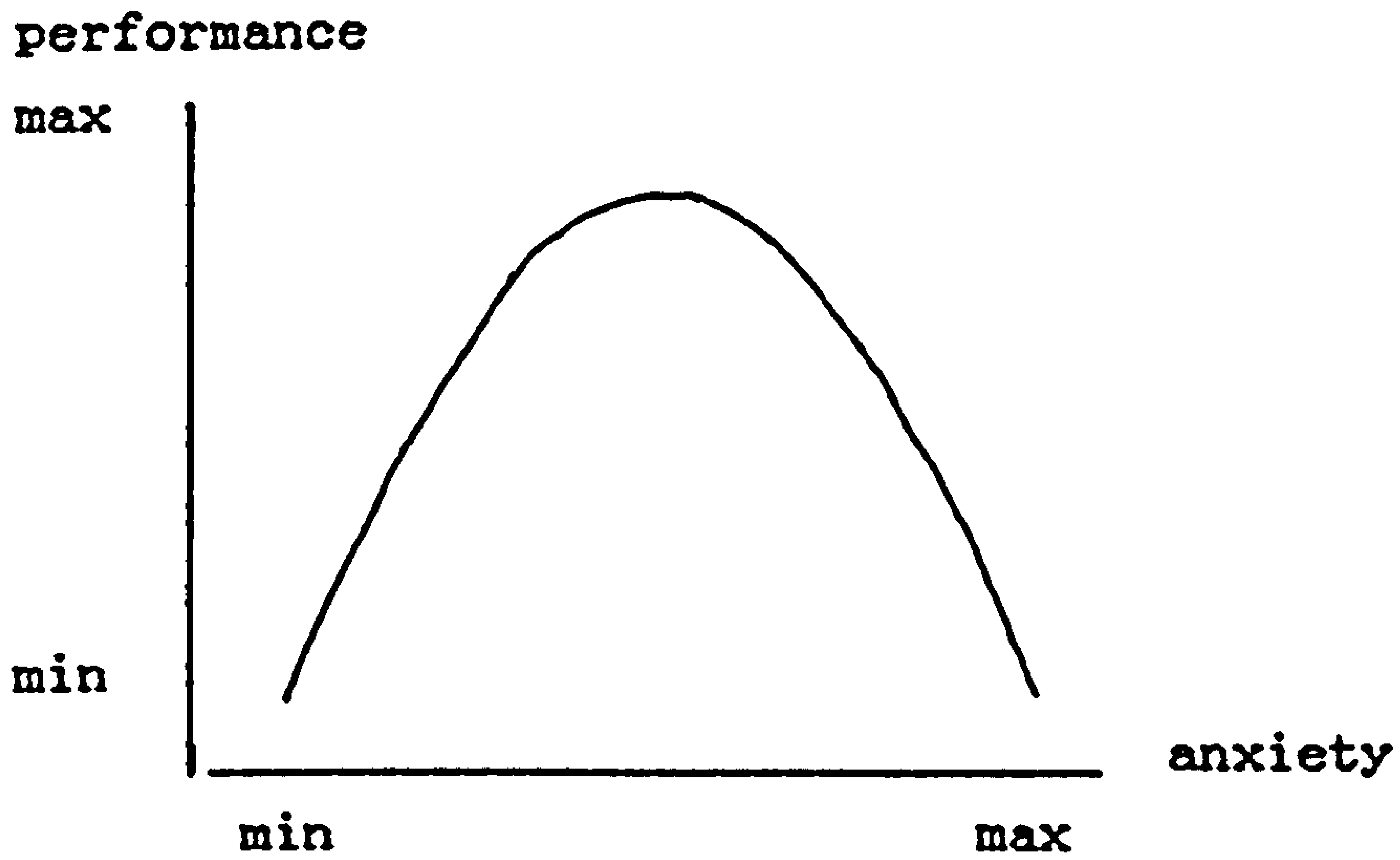
Self-report inventories can be administered and scored quickly, and by almost anyone. They present no special difficulties for group administration. The stability of response given by an individual on different occasions is probably greater than for physiological measures, and the reliability of scoring is greater than for projective measures. However, their use is subject to reactive effects: respondents may adopt response sets, such as acquiesence, or aim to give socially desirable answers.

On balance, for administration as part of a questionnaire to a large group, a self-report inventory is the most appropriate alternative. Within a one-to-one interview situation, behavioural measures or - resources permitting - projective measures might be used, but physiological methods would probably be too obtrusive.

3.2.3 Anxiety and Performance

Most of the research on the relationship between anxiety and performance (or educational attainment) was done in the 1950s by psychologists, rather than by educational researchers (Reed, 1960, p.145). Some of those concerned with the anxiety - performance link focussed on the "Yerkes-Dodson Law". This proposed an "inverted U" relationship between the level of anxiety ("drive" or "motivation") and the level of performance (NOTE 7), for some forms of learning at least; see Fig. 3.1. Put another way, it claimed that, for each individual and each task, there was an <u>optimal</u> level of anxiety, neither too little to facilitate performance, nor so much as to interfere with it.

Fig. 3.1 "Inverted U" Relationship between Performance and Anxiety



The Yerkes-Dodson Law, first proposed in 1908, seems to have caught the imagination of psychologists - perhaps because of its undoubted "common sense" appeal, perhaps because it seems to be "one of the closest approximations to a true scientific principle" available in psychology (Levitt, 1968, p. 144). First proposed as a relationship between fear produced by electric shocks and simple learning in mice, it was then applied successfully to simple human learning, as related both to what would now be called "transitory" anxiety (Stennett, 1957), and also to "anxiety-proneness" (measured by the Manifest Anxiety Scale); see Levitt (1968, pp. 144ff.).

The theoretical support for the Yerkes-Dodson Law seemed to come most clearly from the Iowa School that saw anxiety(-reduction) as a drive - and therefore in theory as potentially facilitating of learning and performance, for simple tasks at least. However, over this period, its researchers produced results that, for the most part, were contradictory and confusing. (NOTE 7a)

At the same time, the Yale psychologists were pursuing their programme which was sceptical of a general anxiety-proneness, and which sought instead to study the individual's way of reacting to anxiety in context, in stressful situations: i.e. whether s/he reacted with "task-relevant" / facilitating or "task-irrelevant" / interfering behaviour. The effect of anxiety would depend on the nature (e.g. complexity) of the task, its perceived meaning, the experimenter, and other aspects of the situation. These researchers began by focussing their attention on academic achievement anxiety and the related fear of failure, and in particular on what they called "test anxiety", as opposed to general anxiety; see e.g. I.G. Sarason (1957).

By the end of the 1960s, the dominant view was that, for academic achievement, high anxiety generally was interfering; therefore the correlation between anxiety and performance was generally negative, and higher for test anxiety than for general anxiety. This view is confirmed in the studies at all levels of the educational system reviewed in Caudry and Spielberger (1971), in which there is little reference to the "Yerkes-Dodson Law". There may be several reasons for this. The breakdown of the Iowa research programme in the late 1950s undermined its major theoretical underpinning. Also, it is notable that most of the articles reviewed or presented in Caudry and Spielberger present data in the form either of differences of means (performances) for two anxiety groups, high and low, or else as product-moment correlations, or F ratios, which are essentially linear measures of relationship. Only two studies presented in the review present results grouped into more than two anxiety levels, and only one gives support to the Yerkes-Dodson relationship.

One study during this period faced the problem of the "ambivalence" of the anxiety variable directly. Alpert and Haber (1960) considered that earlier work confounded two alternatives to the idea that anxiety is debilitating: a facilitating effect of anxiety, and no effect of anxiety. They postulated two types of anxiety, one "facilitating" and one "debilitating" of academic achievement, and constructed a scale for each. Their main finding was that facilitating anxiety added significantly to the power of prediction of college students' results, compared with debilitating anxiety alone. They also concluded that measures of general anxiety and those for test anxiety were measuring different attributes. The approach of Alpert and Haber has only been used occasionally in subsequent work. This may be because the postulation of two types of anxiety is theoretically cumbersome.

3.2.4 Gender and anxiety

Some of the psychological studies on anxiety and performance done up to the end of the 1960s ignored the question of gender; others found that girls reported more anxiety than boys. For example, S.B. Sarason et al. note that high anxiety scores are relatively less common among boys, and suggest that this is because "in our culture, at least, it is generally more difficult for boys than for girls to admit to anxieties, worries, or fears."(1958a, p.294). It should be kept in mind that these writers are concerned with manifest anxiety.

Horner (1968) addressed the question of gender differences in anxiety. She started from the view (based on that of Sarason et al.) that males "tend to defend against the admission of anxiety, since it reflects adversely on their masculinity", but then noted that I.G. Sarason (1959) had found no real sex differences in the "social desirability" of items on the Test Anxiety Questionnaire. She concluded from this that "admitting anxiety in test situations may not be as threatening to men as admitting anxiety in other, more general types of situations" (Horner, 1968, p.15).

In order to help explain anomalies in the theory of achievement motivation (see APPENDIX V3), as well as to develop a more satisfactory explanation for the observed gender differences in test anxiety, Horner postulated a "fear of success", or motive to avoid success. This could be considered along with the motive to achieve (with its positive consequences such as pride), and the motive to avoid failure (with its negative consequences such as shame). That is, women are more anxious in testing or achievement-oriented situations than men, because there are for them negative consequences, and hence anxiety, associated not only with failure, but also with <u>success</u>. These negative consequences for women include loss of self-esteem, doubts about their femininity, and fear of rejection. These consequences arise for women, because intense intellectual striving can be viewed as "competitively aggressive behaviour" (Mead, 1949); this is reinforced if one accepts Freud's (1933a/1973a) claim that the essence of femininity lies in repressing aggressiveness (Horner, p.16). Thus, it is to be expected that females will score higher than men on test anxiety, especially on scales such as the TAQ, which specify the situation, but not <u>what</u> (consequences) one is anxious about.

Thus, Horner's work provides an explanation for higher levels of admitted or expressed test anxiety among women. However, Horner also notes that the psychoanalytical literature suggests that, besides anxiety, defensive reactions against anxiety should be considered. An example of the latter would be the defensive projection by women of achievement motivation into less conflictual situations such as (i) women engaged in activities in the home, and (ii) men engaged in more intellectual and achievement-oriented types of pursuits (Horner, 1968, p.17). Yet Horner's empirical work uses a measure of expressed anxiety for motive to avoid failure rather than any measure based on psychoanalytical theory - though the "projective" measures used for achievement motive and motive to avoid success included indirectly, as well as directly, expressed responses (e.g. denial) to cues that might have represented a threat to the subject (p.105). (NOTE 8)

In their review of studies relating anxiety and performance, Caudry and Spielberger conclude that

> The most likely conclusion appears to be that the relationship between anxiety and achievement is equally strong for the two sexes overall but this relationship may vary as a function of complex situational factors, such as the sex of the teacher or a teacher's value system. (1971, p.37)

This reinforces the importance of the context in assessing results on gender differences in the reporting of anxiety, and in its relationship with performance.

3.2.5 Summary and Evaluation

Based on this review of conceptions of anxiety and research findings since the 1950s, several distinctions can be made as to the type of anxiety under consideration:

First and most fundamentally, what is the role of the unconscious considered to be? Is the anxiety always in principle available for observation or self-report, or might it be, sometimes at least, subject to defense mechanisms that would prevent the subject, and perhaps also an observer, from being aware of it?

Second, what is the context or focus of the anxiety? Is it general or specific? Test anxiety and maths anxiety are examples of the latter. Third, and closely related, is the extent to which the anxiety is considered as a characteristic, a chronic "trait", rather than a transitory "state". This distinction is close to that made between ("cool") attitudes and ("hot") emotions in Sec. 3.1. Note that the positing of state anxiety opens up the possibility that the anxiety can be measured while being experienced (or immediately afterwards).

Fourth, what is the relationship of anxiety with performance considered to be? Are there qualitative differences between "facilitating" and "debilitating" anxiety? In particular, is the relationship linear, or quadratic (an "inverted U")? Finally, how is the anxiety measured - by physiological measures, by overt behavioural means, by clinical (e.g. "projective") methods, or by self-reports?

3.3. The Development of Mathematics Anxiety

In the 1950's, the research literature began to refer to "mathophobia" and "number anxiety" and to present short questionnaires or rating scales to measure it; one of the earliest was Dreger and Aiken (1957). But there were few developments in that period, compared with those concerning general and test anxiety.

In the 1970's, however, there were two important new developments in North America. First, as discussed in Sec.2.3, in the context of a developing "Women's Liberation" movement, researchers were seeking explanations for the apparently poorer performance of women in maths courses and testing, in terms of factors other than innate aspects of ability. For this reason, "math avoidance" (a failure to take maths courses, beyond compulsory ones) was studied - and also as a problem in its own right (Sells, 1972). As we have seen, this led to an emphasis on affective factors for providing at least part of an explanation for alleged female deficits in performance and participation. The notion of "math anxiety" was ideal in this connection. Tobias and Weissbrod (1980) claim that this notion was popularised by Sheila Tobias' (1976) article in Ms magazine. Certainly the mainstream media picked up the ideas of maths anxiety and math avoidance (see e.g. Time, 14 Mar. 1977). In 1977, the US National Institute of Education made a grant of $1.2M (over £3M. at 1990 prices) to researchers to study the causes of maths avoidance among females, especially in the primary and secondary school years.

Second, during this same period, a group that Tobias and Weissbrod call "interveners" sought to develop techniques for diagnosing and treating the symptoms of maths avoidance, amongst male and female students, usually adults. Thus, the concept of maths anxiety has also been widely used, especially in North America, in mathematics workshops and remedial programmes. During this period, questionnaires used to measure maths anxiety - for diagnosis and remediation purposes - were produced.

Most of the material discussed in this section refers to adult students only.

3.3.1 Two mathematics anxiety scales: the Mathematics Anxiety Scale and the Mathematics Anxiety Rating Scale

The two scales most frequently used in the past twenty years are the Fennema - Sherman Mathematics Anxiety Scale (MAS) (Fennema and Sherman, 1976), produced by two of the researchers involved in the research programme mentioned above, and the Mathematics Anxiety Rating Scale (MARS) designed for use in some of the intervention programmes (Richardson and Suinn, 1972; Rounds and Hendel, 1980). It is worth comparing the MARS and the MAS, as to their underlying conceptions and as an indicator of maths anxiety.

(a) The Mathematics Anxiety Scale (MAS)

The MAS is one of 9 domain specific scales which make up the

Fennema-Sherman Mathematics Attitude Scales. These scales were conceived in order to "measure some important, domain specific, attitudes which have been hypothesized to be related to the learning of mathematics by all students and/ or cognitive performance of females" (1976, p.1). The other scales include:

AS (Attitude to Success in Maths, based on ideas of women's fear of success in "male" intellectual areas; see Horner (1972) and sec. 3.2.4);

E (persistent exploratory behaviour, active seeking of challenge, similar to a "problem-solving attitude");

C (Confidence in Learning Maths);

U (Usefulness of Maths);

MD (Maths as a Male Domain); and

M, F, and T (perception of mothers', fathers', and teachers' attitudes towards oneself as a learner of maths).

Fennema and Sherman defined maths anxiety as "feelings of anxiety, dread, nervousness and associated bodily symptoms related to doing maths" (1976, p.4). The two researchers themselves produced a initial set of Likert-type items - each allowing 5 different responses, from "strongly agree" to "strongly disagree". The scale was then validated on US secondary school pupils; "item analysis" procedures used to select the final items aimed to highlight gender differences, and also differences between those taking further maths courses in high school, and those not doing so. This means that we should expect that comparisons using the MAS will have a strong tendency to produce "gender differences" in maths anxiety.

If we examine their items (see APPENDIX P3) with our summary from the previous section in mind, we can note several features. First, this is self-report scale. The assumption is that mathematics anxiety is consciously available to the subject. Second, all the items are "domain specific" (to mathematics). Third, however, when we look at the wording of the questions, five refer to mathematics (as a school subject) in general, and the rest to maths courses, classes, problems, and tests. Thus, the maths anxiety appears to be construed as chronic, rather than as a "transitory" response to an immediately preceding situation. Finally, in terms of its relationship with performance, maths anxiety is apparently construed as "debilitating": the 12 items are scored negative for "anxious" responses and positive for "non-anxious" responses. A high score is thus indicative of low anxiety.

(b) The Mathematics Anxiety Rating Scale (MARS)

Richardson and Suinn (1972) characterise maths anxiety as "involving feelings of terror and anxiety that interfere with the manipulation of numbers and the solving of math problems in a wide variety of situations" (p.551). They start from the observation that "studies emphasising the identification of different types of anxiety have found that different kinds of anxiety lead to different effects on intellectual performance."

To measure MA, Richardson and Suinn produced 98 items which were brief descriptions of behavioural situations, for example, "adding two three-digit numbers while someone looks over your shoulder", in response to which people were expected to indicate one of five different levels of anxiety from "not at all" anxious to "very much". The samples used for validation included over 350 1st and 2nd year education students (80% female), at a large US Midwestern University.

Richardson and Suinn checked on the test's validity (whether it measures what it purports to measure) in a way that was in keeping with their interest in MA intervention programmes, and the evaluation of such programmes: they noted whether there was a decrease in maths anxiety scores when it was administered before and after behaviour therapy given for maths anxiety (1972, p.553). (NOTE 9) Reliability and validity are further discussed in Suinn et al.(1972). For the questions in the 1972 version of the MARS, see Appendix P4.

In terms parallel to our earlier discussion of the MAS, we can note several features of the MARS. First, the responses elicited by the MARS are again self-reports; these refer only to degrees of being "anxious" - not to qualitative aspects of the experiences, for example to physiological indications of anxiety. Second, the MARS test aims to be situationally specific, and the use of the factor analysis (see sec. 3.3.2) aimed to produce even more specific "factors". Third, though the issue is not discussed, the wording of the questions again suggests that the maths anxiety is conceived of as chronic or "trait". Again, the MA is considered as debilitating, rather than facilitating (see the definition above).

(c) Choice of mathematics anxiety indicator

It is worth comparing the MAS and the MARS at this stage, in particular with regard to their usefulness for questionnaire (self-report) research with adults.

First of all, the MAS items refer only to school mathematics in general, or to maths courses, classes, problems and tests. The MARS items, on the other hand, refer to a wide range of situations, not only to do with academic maths - usually college maths, as the MARS was constructed with adults in mind - but also maths in a variety of other contexts; see for example questions 1 and 47 in the original MARS scale (see APPENDIX P4, or the next subsection). Second, the MAS items mention a variety of emotions: "scare", "bother", "worried", "at ease", "uncomfortable", etc. Each MARS item asks how much, for each situation mentioned, the respondent is "frightened by it nowadays".

Third, the MAS (with 12 items) would be more economical of (respondents' and researchers') time than would the MARS (with 98 items). On the other hand, the longer MARS scale would tend, other things being equal, to be more reliable. Fourth, in terms of types of items, both scales used 5 point Likert scales. However, the MAS was symmetrical, ranging over the standard categories, from "strongly agree" to "strongly disagree", whereas the MARS was asymmetrical ranging from "not at all" to "very much". On balance, a scale of available reponses that relates to standard categories and is symmetrical (like the MAS) is more likely to yield responses that can be treated as an interval scale - for example, that can be averaged - at the analysis stage.

On the first point, the MARS is clearly the more appropriate indicator to use for a study of the variation in numerate performance - and in anxiety - across a range of contexts. Indeed, it seemed that it would be desirable to study the MARS' range of contexts more systematically - e.g. by using factor analysis to look for underlying dimensions of the various items, as other researchers had done; see the next subsection. Also, in terms of the practical implications of research like this, being able to separate out aspects of the context of learning or doing maths which cause relatively more anxiety to learners would be valuable for designing "intervention" or remedial programmes. The second and third points suggest using the MARS, though we may want to decrease the number of items. Concerning the fourth point, we could attempt to set up a symmetrical scale of responses for the MARS.

These are the reasons I chose the MARS as an indicator for maths anxiety. I address two of the issues raised - the more systematic characterisation of different contexts of maths anxiety, and the number of items - in the next subsection.

3.3.2 Dimensions of mathematics anxiety

In the previous chapter, we discussed distinctions between school mathematics performance and practical maths performance or numeracy, on the basis of a notion of context. Here it is relevant to ask whether we might distinguish two (or more) types of mathematics anxiety, on the same basis.

Though Richardson and Suinn (1972) characterised maths anxiety as "involving feelings of terror and anxiety that interfere with the manipulation of numbers and the solving of math problems in a wide variety of situations", they emphasised that the MARS was a measure of the specific anxiety "associated with the single area of the manipulation of numbers and the use of mathematical concepts" (p.551). This suggests that they resolved the tension between the two quotes in favour of seeing mathematics as basically context-free, in a way that was considered critically in the previous chapter.

Using simple notions of "school maths" and "practical maths", as deveoped in Ch. 2, I attempted to categorise the mathematical / numerate activity referred to by each of the 98 MARS items into one of five groups: as "clearly" practical or "clearly" school/college maths, "questionably" practical or school/college maths, or ambiguous.

Of 98 MARS items, I classified 25 as "clearly practical maths" items. Examples would be:
Qu. 10 Totaling up a dinner bill that you think overcharged you.
Qu. 47 Reading a cash register receipt.
Qu. 48 Figuring the sales tax on a purchase that costs more than $1.00.
Qu. 64 Deciding which courses to take in order to come out with the proper number of credit hours for full-time enrolment.
Qu. 87 Being responsible for collecting dues for an organization and keeping track of the amount.

Examples of "clearly school maths" items (48 of 98 so classified) would be:
Qu. 26 Signing up for a math course.
Qu. 54 Taking an examination (final) in a math course.
Qu. 72 Being given a homework assignment of many difficult problems which is due the next class meeting.
Qu. 74 Thinking about an upcoming math test one day before.

Examples of "ambiguous" items (25 of 98 so classified) would

be: :
Qu. 14 Adding up 976 + 777 on paper.
Qu. 81 Realising that you have to take a certain number of math classes to fulfill the requirements in your major.

On my reading, it is possible to classify at least three-quarters of the MARS items more or less clearly - on the basis of the meaning of the wordings - into those relating to "practical maths" situations and those relating to "school / college maths" situations, the latter including involvement with maths classes, textbooks, exercises, tests, exams, etc. A few items, however, cannot be so straightforwardly classified. Qu. 14 is ambiguous in that, though no context is explicitly mentioned, the carrying out of the operation <u>on paper</u> tends to be characteristic of school maths activity - but not exclusively so. Qu. 81 is ambiguous in a different way: the feelings that come from realising that you have to take a certain number of maths classes may relate to the activity of being a college student (in one of a variety of majors) - or they may relate to the activity of school (or college) maths.

A number of researchers have considered the dimensionality of the MARS; see APPENDIX V4. In particular, Rounds and Hendel (1980) found two factors, described as follows:

Factor 1 - named <u>mathematics test (or course) anxiety</u> by the researchers: accounting for 31% of the variance , loading on 42 items (see APPENDIX V4 for explanation of these two technicalities). About one-third of these reflected apprehension about anticipating, taking, and receiving the results of maths <u>tests</u>, while two-thirds referred to activities directly associated with maths classes and <u>courses</u>. Examples: Qus. 26, 54, 74, 81; see above.

Factor 2 - named <u>numerical anxiety</u>: accounting for 8% of the variance, loading on 44 items referring to <u>everyday</u> concrete situations requiring some form of <u>number</u> manipulation (such as addition and subtraction). Rounds and Hendel found that slightly over a half of the 44 items refer to practical skills necessary for making money decisions, a quarter refer to a wide variety of practical situations, and about a quarter refer to the use of elementary arithmetic skills with no apparent context of application (p.142). Examples: Qus. 10, 14, 48, 64.

To summarize the results of the factor analyses discussed more fully in APPENDIX V4, there is a fair amount of agreement in the literature that there are at least two main factors of maths anxiety - one related to the use of numbers in everyday situations, including those relating to money, and another relating to academic maths courses, lessons, textbooks and assessment.

What makes Rounds and Hendel's work important here is that they address the issue of the context where the numerical work is done, and they interpret their results to indicate that anxiety about maths may be "situationally specific and not transituational". In particular, Rounds and Hendel's work seems to make a distinction parallel to that made between "school maths" and "practical maths" cognition and performance in Ch.2.

3.3.3 Mathematics anxiety and performance

Most of the research from the 1970s and 80s is based on a conception of maths anxiety as "debilitating", i.e. as having a negative relationship with performance. Several factors seem related to this change, including:

- the decline of behaviourist research programmes which had theoretical commitments to the Yerkes-Dodson inverted-U relationship, though not much confirmatory evidence (see Sec. 3.2); and
- the rise of feminist research programmes, where maths anxiety is used as the basis for explanations of supposed female deficits in participation and performance.

However, Reyes points to the difficulties of justifying causal explanations, when the research design is non-experimental and the data analysis is based on correlations and regression or analysis of variance models (1984, p.566). Even if we were convinced that a causal relationship was operating, we might wonder about the direction: does maths anxiety influence performance - or vice versa - or both? Most recent reviews agree even that "conflicting evidence exists on the ability of math anxiety measures to predict performance in mathematics" (Llabre and Suarez, 1985, p. 283; my emphasis).

Most studies do, however, find a negative correlation (zero-order, i.e. uncontrolled) between maths anxiety and performance. For example, Richardson and Suinn (1972) found a correlation of -.64 (n=30 3rd and 4th year psychology students) between MARS scores and score on the maths section of the Differential Aptitude Test, which was timed for 10 minutes. This is one of the highest correlations found in the studies reviewed. But there are some problems:
(i) The two tests were administered in the same session, with the MARS first; thus, the anxiety measured by the MARS is presumably operating as trait, rather than as "state" anxiety; this ordering further supports the view of the MARS as a trait anxiety measure because of the wording of the items (see sec. 3.3.1).
(ii) As with other research reporting values of Pearson's r (a measure of linear correlation), there was apparently no attempt to examine the detail of the relationship, e.g. through scatterplots. Here, a linear negative / debilitating relationship beween anxiety and performance was assumed, since the aim was to show ("predictive") validity of the MARS.
(iii) There was no attempt to control for other variables.
Problems (ii) and (iii) are typical of studies in this area. (NOTES 11a, 12a)

Resnick et al. (1982) found relatively low MARS scores in a sample of (relatively young) undergraduates enrolled in several maths courses in a private northeastern university. In using the "change in R-squared" criterion, they found that the MARS made little additional contribution to predicting Maths course performance, beyond that made by SAT-Verbal, SAT-Math and converted high school rank scores. Of course, because Resnick et al.'s three predictor variables are all performance / ability measures (though each taps something different), they are likely to correlate highly with the course grade, and therefore at least one or two are almost certain to be entered into a stepwise regression model before the MARS. Another reason for the MARS' low predictive contribution in this study may be the restricted range of MARS scores in the sample (p.46).

Llabre and Suarez (1985) administered Plake and Parker's (1982) "revised" MARS (see sec. 3.3.2) to a relatively young sample (18-19 years), 41% Hispanic, none of whom had taken more than two years maths at high school. They found that after controlling for mathematics aptitude (SAT-Math), maths anxiety did not significantly improve the prediction of grades in an introductory algebra course, for either men or women (1985, p.285). (The limitation discussed in connection with Resnick et al.'s work does not apply with so much force here, because there is only one other predictor variable (SAT-Math) besides the MARS.) (NOTE 12)

To summarise, the evidence is conflicting on the relationship between maths anxiety and performance, as Llabre and Suarez note. In addition, many of the studies reported suffer from one or more methodological limitations. First, these studies use measures only of trait anxiety, not of "state" maths anxiety. (This limits their scope for taking account of the context of maths anxiety.) Second, correlations are often reported which though statistically significant are small in R-squared terms. Third, sometimes anxiety - performance relationships are examined using only simple differences in means or correlation coefficients - without simultaneously controlling for other variables indicated as relevant by their own and other studies; multiple regression methods are called for. Finally, the use of <u>linear</u> correlation and regression methods by themselves do not allow the researcher to address the possibility of non-linear, e.g. "inverted U", relationships between maths anxiety and performance.

Llabre and Suarez themselves suggest that predictability may be dependent on sample characteristics; e.g. gender, "amount of interaction with maths" (e.g. no. of years of high school maths), and other affective variables, including test anxiety (1985, p.283). These conclusions will be used in the construction of the conceptual map in Ch.4.

3.3.4 Structural bases of maths anxiety

The previous subsection discusses the relationship between mathematics performance among college students (in the USA) and maths anxiety. Here I will focus on the relationship, in the same or similar populations, between maths anxiety and the three social structural variables considered in connection with maths performance and numeracy in Ch.2 - namely, gender, social class and age - as well as the number of maths courses taken in secondary school.

(a) Gender

In the research programme on women and maths, exemplified by Fennema (1979), such gender differences in performance as are acknowledged to exist in mid- to late adolescence, are explained by differences in course-taking. These latter differences are in turn explained by differences in attitudes, including differences in maths anxiety; the latter can then be seen to explain any deficits in female performance that are found to exist. If MA is seen as debilitating - as it generally is in this programme - then females would be expected to "have more of it", and to score correspondingly higher on maths anxiety scales. (In contrast, Dreger and Aiken's early discussion (1957) of "number anxiety" did not even discuss the concept in gender-specific terms.)

However, when we look at the empirical results, we again find them to be mixed. Many studies appear to find no gender differences in maths anxiety, for example, Richardson and Suinn (1972) and Morris et al. (1978). Brush (1978) found higher maths anxiety among women in the one of her samples, but men had taken more maths courses. Women who had taken advanced high school maths provided self-ratings of maths anxiety level that were not different from men's.

Other studies have found gender differences, however. Dew et al. (1983) found more maths anxiety, as measured by MARS and MAS, among women - but the difference, though statistically significant, still only amounted to about one-fifth of a standard deviation for the whole sample. Llabre and Suarez (1985) found statistically significant gender differences in the revised MARS, but not in general anxiety. (NOTE 13)

(b) Social Class

Social class or socio-economic status (SES) has been a much less central concern than gender, in the main body of work done in the USA on maths performance and maths anxiety since the mid-1970s. SES was included in some of the studies reviewed in Ch.2, though most of these were based on schoolchildren up to age 17 or 18.

Only a few studies of specifically mathematics anxiety have included social class (or SES). Betz (1977) found effectively no correlation between Fennema-Sherman MAS scores and mother's or father's "educational level". She found significant correlations between MAS and "mother's work involvement" outside the home for two of her three subject groups. However, this latter is not necessarily a valid indicator for social class or SES; also the categories do not constitute an unambiguously ordinal scale, so that the use of correlation coefficients is problematical. Kincaid and Austin-Martin (1981) found no relationship between status of parents' occupations - professional or non-professional - or their "math-relatedness", and students' classification as high or low on the MAS. However, this is a very limited indicator for parents' occupational activity.

To summarize, no dependable differences in maths anxiety are found in a very limited literature. For example, there were no studies found using the MARS.

(c) Age

One of the disadvantages of older adults in performance studies (see sec. 2.3.3) is that they tend to have left school, and academic study, a longer time ago. Therefore, they may well be anxious about study of academic subjects that are learned mainly in school, or in a distinctive way in school - and this is often believed to be the case for maths. In principle, it should be possible to separate the age factor from the number of years since school, or since last academic study.

There are almost no findings on the relationship between age and maths anxiety. Betz (1978), in a sample aged between 17 and 34, found a positive correlation between age and MAS (NOTE 11) for two or her groups. There are again no findings based on the MARS.

(d) Course-taking

It is reasonable to expect subjects who have taken fewer maths courses to be more anxious about maths. Betz (1977) found negative correlations (NOTE 11) between the MAS and number of years of high school maths for all 3 courses and both genders. Brush (1978) found generally higher MARS scores associated with lower "intensity of participation" in maths (choice of certain majors, number of years of high school maths, whether or not enrolled in calculus).

3.4 Summary

For a number of reasons, including the prominence of maths anxiety in a well-developed literature, I focus my work in the affective domain on maths anxiety (MA). However, other affective variables are to be included in the conceptual map for the questionnaire: confidence; finding maths difficult; finding maths useful; and finding maths interesting.

As an indicator for maths anxiety in a self-completion questionnaire, the Mathematics Anxiety Rating Scale MARS was preferred over the Mathematics Anxiety Scale (MAS) for reasons of reliability and validity: given my emphasis on the context of mathematical / numerate thinking, a majority of the MARS items include a description (albeit minimal) of a context. Further, the research pointing to a division into "maths test / course anxiety" and "numerical anxiety" (Rounds and Hendel, 1980) suggested I could measure maths anxiety so as to distinguish academic anxiety from anxiety in practical contexts; this was meant to parallel the distinction between "school maths" and "practical maths" (numeracy) discussed in Ch.2.

The more recent literature on maths anxiety and maths performance reports conflicting results. None of the studies reviewed analyse the data in a way that is sufficiently precise to confirm (or not) an "inverted U" relationship between anxiety and performance; such a relationship would indicate that moderate levels of maths anxiety are facilitating, whereas higher or lower levels are (relatively) "debilitating". When we consider the relations between social structural variables and maths anxiety, we find that the evidence is conflicting for gender, and scarce for social class and age differences.

Turning to an overall evaluation of the research on mathematics anxiety, I was struck by the frequent lack of attention to the measures chosen, as well as by a common failure to use appropriate analytic tools in an appropriate way. One aspect of the lack of attention to the measures chosen, to their face validity, seems to be a failure to read the items with a view to their likely meaning to the members of the target population. For example, Fennema and Sherman state that their Effectance Motivation (E) Scale, a measure of "problem-solving attitude" is "not intended to measure interest or enjoyment of mathematics" (1976, p.5). Yet when we examine the twelve items used to measure E, one reads "mathematics is enjoyable and stimulating....", another refers to (not understanding) others' enjoying maths, and two others refer to maths puzzles and problems being "boring" or "not appeal(ing)". In general among these researchers, there appears to be a reluctance to look at language, to read the meanings of the words in the items, and also to investigate the readings of these items by the respondents themselves.

This may be because one of the favoured methods for investigating these meanings is by calculating the inter-correlations of the items, as in factor analysis. However, coefficients of correlation between levels of response to to items do not always provide a good measure of the closeness of meanings.

Many of these studies suffer, too, from inadequate controls for other variables. As for methods of analysis, at a time when the theorists were debating the merits of the Yerkes-Dodson inverted U relationship between anxiety and performance, many empirical studies in psychology were using inappropriate tools, e.g. comparisons of two groups only, or linear correlations / modelling.

Finally, this chapter has raised the relationship between the cognitive and the affective, not only in terms of empirical links between performance outcomes and anxiety, but also in terms of theoretical models. In the "differential" models, exemplified by Fennema's generic model (Sec.3.1), the links are produced by what are seen as "causal" relationships. The "external", the social, the cultural, socialises the individual, so that values and affect are "internalised"; affect in turn influences cognitive outcomes in the individual. In these studies of educational psychology, the process of socialisation is, to a greater or lesser extent, bracketed as largely the province of sociology, anthropology and social psychology - whereas the causal links assumed between cognitions and affect are considered to be accessible to analysis using the techniques of correlation and statistical modelling. Affect in this approach tends to be represented, not by "hot" emotion, but by "cool" attitudes; in fact, there is a tendency here to see as stable characteristics both the cognitive ("performance levels", "skills", if not innate abilities) and the affective ("personality", "traits", as in trait anxiety).

In contrast, the approach Mandler (1989b) calls "micro" tends to place more emphasis on affect as emotion, in studying the process of problem-solving. Thus emotion is "constru(ct)ed" as a result of the cognitive evaluation of a physiological arousal, which is itself a result of an interruption of a plan. Thus the links between the cognitive and the affective are produced by assimilating affect to some extent under the cognitive umbrella. However, this approach, such as it is described at the beginning of this chapter, is not easily able to take account of the effect of the social.

For the quantitative (questionnaire) part of this research, a version of the differential model discussed above was considered promising as the basis for the conceptual map. And within this approach, the MARS appeared promising as a measure for maths anxiety. Chapter 4 pulls together these ideas on models, affect and performance in context, from this and the previous chapter. (The second, qualititive, part of the thesis will draw on ideas from micro approaches.)

CHAPTER 4 : METHODOLOGY OF THE QUESTIONNAIRE

> Since the processes of determination in the social world are subjective in important ways, involving actors' meanings and intentions, the survey researcher has to face the task of measuring these aspects.
>
> (Marsh, 1982, p.147)

In the previous chapter, I referred to Mandler's (1989a) distinction between "macro" and "micro" approaches in the study of affect and mathematical cognition. He saw macro approaches as emphasising overall measures of relatively stable individual characteristics such as trait anxiety and performance level, whereas micro approaches are focussed on the process of an individual confronting a particular problem. This distinction seems to fit well with my resolve to combine methods which would be appropriate to both these sorts of approaches - by presenting a structured questionnaire to a large sample of adults, and by giving a less structured interview, including some problem solving, to a smaller subsample. (NOTE 1) The methodology of the structured questionnaire survey is described in this chapter, and that of the less structured interview is discussed in Ch.9.

In Ch.1, I presented a list of objectives for this thesis. The following is a selection of those which appeared able to be pursued using a survey approach:

(ii) to describe the levels of numeracy amongst a selected population of adult students, and to compare them with those of the national population surveyed for the Cockcroft

Report;

(iii) to consider critically a number of earlier findings about mathematics performance and anxiety which are widely considered to be valid; for example, "Females perform better than males.... " and "Mathematics anxiety is debilitating.... ";

(iv) to review the conceptions of "context" used in mathematics education and psychology, and to assess certain of these conceptions through empirical research;

(vi) to document the range of affect related to mathematics and numbers amongst members of the sample; and

(viii) to examine the relationship of cognition and affect, both across samples of adults, and for particular subjects.

In this research, aims (ii) and (iii) were studied by posing questions / formulating hypotheses, based on my initial ideas developed in reading the literature - and by investigating them in the survey. Aims (iv), (vi) and (viii) were studied in the same way, i.e. using the questionnaires, to some extent, but here the interviews were also useful (as well as the literature reviews themselves).

As a first step I needed to develop a conceptual map, showing the key variables and the expected inter-relationships among them, that would be used to guide the formulation of hypotheses, the research design (including the specification of indicators for the key variables), and the data analysis. In Sec. 4.1, I discuss the conceptual map (based on the "differential" model discussed in the last two chapters), and also a number of research questions and hypotheses which are based on the conceptual map, or on findings from previous work. Sec. 4.2 discusses the choice of indicators, and the resolution of sampling and other research design issues. Sec. 4.3 reports on the fieldwork.

4.1 Conceptual Map and Hypotheses

Specifying the institutional setting and the working population of adults was necessary before the conceptual map and hypotheses could be clearly set down. Hence it was a decision made early in the research.

4.1.1 Institutional setting and working population

At the beginning of my research, I had to decide between studying a sample of adults from the population at large, or a sample of adult students in tertiary education. The former would have had the advantage of being more representative, but the likely difficulties of contacting them, and the costs of travel etc., would have been great. The students would be more convenient, and would also be a more appropriate group with whom to study the differences between academic maths and numeracy. Therefore, I decided on studying an appropriate group of tertiary students. But which group? Here the criteria were an appropriate range of ages (i.e. beyond 18-21 year olds) and experience (e.g. paid work and raising a family before college entry), as well as convenience and access.

Thus I decided to conduct my research at one particular Polytechnic, where I had been a member of the teaching staff for some years. The Polytechnic had (and continues to have) a relatively high proportion of "mature" students: for the two courses studied, 60% to 70% of entrants were mature (i.e. 21 years of age or over) and many were returning to study after some years of work or child-care. Further, up to half of these mature students were admitted without "traditional" qualifications (i.e. 2 A-levels). These were groups with a wide range of experiences outside of school.

Within the Polytechnic, I chose to study entrants to the BA Social Science (BASS), and the Diploma in Higher Education (DipHE or DHE). At the time of the survey (1983-85), the DipHE was a two year diploma - basically equivalent to two years of a three-year degree (NOTE 2); students could specialise in two or more "Sets", drawn from Quantitive Methods, the natural sciences, the social sciences, education, the humanities, and the performing arts.

Doing my research at this Polytechnic, and with this working population of students, yielded a number of advantages, particularly with respect to convenience and access to respondents, and to data:

(i) I could ask colleagues for time at the end of their lectures in order to ask groups of students to reply to my questionnaires - with a fair hope of a favourable response;

(ii) I could ask students to let me interview them, using their pigeon-holes, or even directly: I was already known to all of the students in the group sampled for interviews (BASS Year 1) (NOTE 3); and

(iii) I had access to course records, so that I could check the numbers supposed to be registered for a course, or the exam results in Maths of a particular student.

Of course at the same time, there were possible disadvantages. My position as lecturer in Mathematics / Statistics, and my role as Maths coordinator for BASS Year 1, led to dangers of "reactive effects", especially in the interviews. This problem was addressed by producing a "reflexive account" for the student population as a whole, plus one for each interview; see Sec. 9.3 and Ch. 11.

Overall, I would argue that the choices of this Polytechnic, and of the B.A.Social Science and the DipHE (later the "Modular Degree"), were appropriate, because of the availability of many mature students, across the range of arts and science subjects: this promised a good number of responses, from a population that was as close to being representative of the population of adults in the UK as any face-to-face higher education institution could provide.

4.1.2 A working conceptual map

The conceptual map I used in the survey phase of the research is related (in slightly simplified form) to Fennema's recently presented (1989) "generic model" for research in affect and outcomes; see Secs. 2.3 and 3.1. In her model (see Fig. 2.1), "external" (i.e. social) factors influence what she calls "mediating learning activities", both directly and indirectly through affect, and these learning activities in turn influence mathematics education outcomes. See Sec. 3.1 for further discussion of other models relating affect and outcomes.

As indicated by the aims selected above, the main outcome variables of interest at the beginning of the study were: performance - not only in "abstract" or school maths, but also in numeracy or practical maths (as discussed in Sec. 2.1) - and mathematics anxiety. This division of performance into school maths (SM) or "practical maths" (PM) types was a way of trying to take account of context; see sec. 4.2.2. Similarly, I aimed to take account of the context of maths anxiety by using items both for maths test / course anxiety, and for numerical (i.e. practical) anxiety, as proposed by Rounds and Hendel (1980). Consequently, I was also interested in the relationship between performance and maths anxiety in specific contexts.

Much of the US research reviewed in Chs. 2 and 3 used the concept of "participation" or the number of mathematics courses taken, both as an outcome and as a determinant of maths performance. However, in the UK, most students have taken maths courses throughout the first five years of secondary school - even before advent of the National Curriculum. Therefore I have here focussed instead on the type of exam passed (GCE vs. CSE at 16+), as well as the level (e.g. A-level, 16+, etc.). Thus the concept of participation gave way to that of qualification. (NOTE 4)

The conceptual map was built up as follows; see Fig. 4.1. The earlier discussion of the literature (in Chs. 2 and 3), and objective (iii) for the thesis (see beginning of chapter), emphasised the importance of social structural factors such as gender and social class in relation to SM and PM performance, and (of gender, at least) to maths anxiety. In addition, I was interested in age as a basic variable, since "mature" students were seen as having special strengths and needs, and I hoped that age might act as a "proxy" for experience in practical, out-of-school activities that might require numerate thinking.

My including not only 18+ students, but also mature students, raised the issue of whether the relevant unit of analysis for social class is the student's original parental family social class (as in much of the literature reviewed in Sec. 2.3), or the student's "own" current social class. At this stage, the dilemma was resolved in the way that would allow most flexibility at later stages - by including both parental social class and student's own social class in the conceptual map.

As for other social variables, I had decided against including in the questionnaire the sorts of "social" variables discussed by Fennema et al., for reasons discussed earlier (Secs. 2.3 and 2.4); these included my aims of emphasising affect and social structural variables, and my concern that the questionnaire should not be overloaded for the completion time available (see Sec. 4.3).

In the conceptual map, <u>affective</u> variables can be considered to "intervene" between the basic social variables (gender, social class, age) and the outcomes. As discussed in Ch.3, these variables include:
- maths anxiety (also an outcome);
- confidence;
- perceived difficulty of maths;
- perceived usefulness; and
- perceived interest.

While I decided to focus my study of the affective on maths anxiety (MA), I nevertheless resolved to include indicators for confidence and the other affective variables. In order to allow for differences in <u>context</u>, I aimed to distinguish between school, everyday and work (where applicable) contexts in the student's past activities, and to tap his/her expectations about the Polytechnic as a setting for using numbers and mathematics. (NOTE 5)

The version of the conceptual map as developed is shown in Fig. 4.1. The basic social variables of gender, social class and age, as well as qualifications in maths (exams passed), are shown on the left of the diagram, with the main outcomes of performance and anxiety on the right. The intervening affective variables of confidence, perceived difficulty, perceived usefulness and interest in maths are shown in the middle. Maths anxiety plays a dual role both as outcome and as affective variable.

4.1.3 Research questions and hypotheses

For some of my areas of interest, it was possible to formulate hypotheses, based on the literature review and my own developing ideas, about what was expected at the data analysis stage of the study. For others (where the literature or my own ideas were less specific), it was possible only to indicate the sorts of research questions I wished to pose, or aspects of performance or affect I wished to investigate. In this subsection, the research questions and hypotheses will be presented in broad form categorised according to the several areas of interest:

(a) overall levels of performance;
(b) specification of contexts of performance;
(c) overall levels of maths anxiety;
(d) specification of contexts of maths anxiety;
(e) gender differences in performance and in affect;
(f) social class differences in performance and in affect;
(g) differences related to age and to maths qualifications;
(h) relationships between performance and maths anxiety; and
(i) other relationships.

(a) Overall levels of performance

The main basis available for appreciating the overall levels of performance in the Polytechnic sample was a comparison of my results with those produced by one of the national surveys, the most suitable of which was the ACACE's; see Sec. 2.2. I expected the Polytechnic students to perform substantially better than the ACACE sample - because the Polytechnic students were likely to have stayed in full-time education longer on average, and to have better maths qualifications, and greater confidence, too. Thus, I expected the Polytechnic sample results to be superior, both overall, and for each individual question.

Results are given in Sec. 5.2.

(b) Specification of contexts of performance

Assuming that performance items on the Polytechnic questionnaire could be divided into practical maths (PM) and school maths (SM) types - indicative of performance in two different types of contexts, I first considered the correlation between the overall scores on "practical maths" and "school maths". This should in theory be close to 1, if these subscales were "measuring the same skills" - though allowance must be made for measurement error - whereas it would be substantially less than 1 if, as I expected, they were measuring different types of performance.

I also was interested in comparing the success rates on practical "money" items, with "school maths" items of similar content and difficulty. However, it was difficult to advance specific hypotheses, in the absence of prior information about item difficulties. (NOTE 6)

Results are given in Sec. 5.3.

(c) Levels of maths anxiety

No systematic comparisons of the levels of maths anxiety expressed were attempted between this research and the US research discussed in Ch.3. Some of the difficulties were cultural: this was the first time to my knowledge that the

MARS had been used outside the USA, and it was uncertain whether the descriptions of the situations for each item, or the words attached to each scale value, could be considered as comparable across the two cultures. Also the original MARS included 98 items, whereas we had selected a subsample of items for this study. Other difficulties were technical: the original MARS scale used a 5-point "non-symmetrical" scale, whereas my discussion emphasised the value of a symmetrical scale; see sec. 3.3.1.

(d) Specification of contexts of anxiety

Some of the literature reviewed (see sec. 3.3.2) had divided maths anxiety items into "numerical" (NA) and "maths test / course" (TA - NOTE 8) dimensions, so as to capture different contexts of anxiety. I aimed to investigate the extent to which this division was reproduced in my study of a British sample, using factor analysis. I also wished to study the inter-correlations of these dimensions with items produced to measure general anxiety, "state" (transitory) anxiety, and also confidence in maths.

The initial intercorrelations are given in Sec.5.4, and the factor analyses in Sec.6.1.

(e) Gender differences in performance and affect

A major focus of interest from the literature review was differences in performance between men and women. For school maths (SM) items, many studies of older secondary pupils and some of adults showed differences in favour of males. Therefore I expected that <u>uncontrolled</u> gender comparisons were likely to favour men. For practical maths (PM) items, the results for the ACACE numeracy questions, which formed the greater part of the "practical maths" scale, showed clear gender differences on most questions (see sec. 2.2.1). On the other hand, to the extent that these were based on activities familiar to both genders, there was no reason to expect one group to perform better than the other; see APPENDIX Q4 on indicators for practical maths performance.

Of course apparent differences in gender (or other) results might also be produced by selection effects. Here, for example, these might operate if the women students were either less well-qualified in school maths than the men, or if the women were older - and hence, say, no longer as familiar with the activity of school maths. (NOTE 6a) In considering any gender differences that might be observed, therefore, I needed to control for differences in maths qualification, and in age.

There might also be interactions in the effects of two or more of these factors; for example, if there were greater barriers to a woman's taking and passing O- or A-level maths, the advantage in performance conferred by the qualification might be greater for a woman than for a man; this would result in a "qualification by sex interaction effect" for performance. Similarly, the American research reported on 17-year olds by Armstrong (1980) in Sec. 2.3 suggested that women might show greater social class differences, in participation and performance, than men.

As for affect, the literature review produced conflicting results on gender differences in maths anxiety. In this study, because of my experience in teaching similar groups, and given that these scales are all self-report measures, I expected women to report higher levels of maths anxiety - in uncontrolled results at least. I expected such gender differences both for maths test / course anxiety (TA) and for numerical anxiety (NA), and for the measure of state anxiety - but not necessarily for the measure of general anxiety (GA). Similarly, I expected men to report a higher level of confidence in maths.

For perceived difficulty in using maths / numbers, I expected women to report a higher level for school maths activities, but not necessarily for work or "everyday" contexts (recalling the lack of gender differences in the

ALBSU results on self-rating in numeracy). I was not certain whether either group would report a higher level of use of numbers / maths, in work or in everday contexts.

Initial uncontrolled results for both performance and affect will be presented in Sec. 5.5, and modelling using appropriate controls (especially for differences in maths qualification, and in age) in Ch.6.

(f) Social class differences in performance and affect

Since the conceptual map included social class, both parental background and the student's own occupation, it was necessary first to investigate any relationship between the two. I expected the relationship to be fairly close, but also that there would be some amount of intergenerational "upward social mobility". (NOTE 7)

In this discussion, it is important to note the following terminology and abbreviations - given that there are two social class variables, each with two main categories. For parental social class (SCP), the main categories used were middle class (MC), working class (WC), and mixed; for student's own class (SCS), based on the most recent job (if any), they were: non-manual full-time (NM), manual full-time (MAN), and other.

Following the literature review, I expected students from MC backgrounds to perform better on school-type questions than WC. For practical problems, I expected such a difference also, though perhaps not as great (relative to the standard deviation for the distribution as a whole). I expected students from mixed parental backgrounds to score somewhere between the MC and WC groups. Again, selection effects needed to be controlled for, in terms of qualification in Maths and age.

In terms of affective factors, the literature gave little guidance. I expected on general grounds that those with MC parental backgrounds would have lower anxiety about maths in the school context at least - i.e. on the maths test anxiety dimension (and on state anxiety items). I also expected the MC repondents to report a higher level of confidence in maths.

Turning now to student's own occupation (SCS), I expected those in NM jobs, on average, to have used numbers / maths more <u>at work</u> than those who had MAN jobs. This greater familiarity with numerate aspects of work might lead, I expected, to better performance in PM by the NM group over the MAN group: the uncontrolled differences would of course depend on the correlation of SCS with SCP (and with other variables), but I expected some SCS differences to remain when parental SC, etc. were held constant. For the same reasons, I expected the NM group to report lower numerical anxiety - but not necessarily lower maths test anxiety.

Initial uncontrolled results for both performance and affect will be presented in Sec. 5.6, and modelling using appropriate controls in Ch.6.

(g) Differences related to age and to maths qualifications

Because age was included in the conceptual map mostly as a controlling variable, only the initial results for the performance and maths anxiety variables will be presented in APPENDIX R8. (NOTE 7a) Similar results for differences in maths qualifications are presented in APPENDIX R9. (NOTE 8a)

(h) Relationships between performance and maths anxiety

First of all, I expected to find negative correlations between the two dimensions of performance and the two dimensions of maths anxiety. More precisely, on the basis of I expected a higher correlation for practical maths (PM) performance with numerical anxiety (than with maths test anxiety), and a higher correlation for school maths (SM) performance with maths test anxiety (than with numerical anxiety). All these would be using <u>linear</u> measures of correlation.

Through using regression modelling, I aimed to judge the "explanatory power" (importance) of maths anxiety for performance differences - above that provided by the basic structural variables - by checking whether maths anxiety added to the "variance accounted for" in these controlled performance models. Further, despite the lack of support in the recent literature, I was still curious about the possibility of anxiety as facilitating (see sec. 3.2.3 and Alpert and Haber, 1960). I wondered whether I would find support for the idea of an "inverted U" (i.e. quadratic) relationship between maths performance and maths anxiety.

Results are given in Sec. 5.7 for the correlations, and in Ch.6 for the modelling.

(i) Other relationships

As in earlier research (see Sec. 3.1), I expected to find a positive correlation of confidence in school maths with SM performance, and a smaller positive correlation with PM performance.

As for relationships between affective variables, one of those expected related to the sort of familiarity with numbers discussed in Ch.2. Familiarity should be positively related to perceived usefulness (or even more clearly to actual use) in practical contexts, and negatively related to perceived difficulties. Therefore, I expected the measures of perceived usefulness of numbers / maths in work, and in "everyday life", to be correlated negatively with the measures of perceived difficulty in these two contexts, respectively.

Results are given in APPENDIX R10.

4.2 Research Design

In this section, I discuss the samples of students that were chosen and the design of the questionnaire.

4.2.1. Samples of students

The choice of the working population for the study as the students at a particular Polytechnic, entering the BA Social Science (BASS) and the DipHE (DHE) courses over the three years 1983-85, has already been discussed in sec. 4.1.1. Thus, the numbers completing the questionnaire in each year and course group are shown in Table 4.1 (total n = 935). It is possible to give only a rough estimate of non-response, for reasons explained in sec. 4.3.3 below.

On the BA Social Science Year 1, Mathematics was compulsory, and was taught as one of the strands of "Methods and Models", along with the Philosophy of Science. On the DipHE, on the other hand, for students taking certain Sets, QM100 (Maths) was not compulsory. Thus, besides including all the students on the DipHE taking QM100 over the three years, students taking CM100 (the Communication Studies Basic Module) were brought in as control groups in 1984 and 1985: most of the latter were not studying maths.

There were therefore eight samples of respondents to the questionnaire; these could be designated by course and year of entry as, say, "B83" or "C85" or "D84", where:
B = BA Social Science, 1st year;
C = DipHE Communication Studies Basic Module; and
D = DipHE Quantitative Methods Basic Module.
During the same years, small sub-samples of BASS students were selected and interviewed at the end of the academic year, in June; see Ch.9.

4.2.2 Questionnaire design, indicators and coding

The questionnaire was produced in 1983, 1984, and 1985 versions, with slight differences in wording between the BASS and the DHE versions; see APPENDICES Q1 - Q3. It was organised into three sections or "scales".

The "Experience Scale" included questions corresponding to social and affective variables in the conceptual map (sec. 4.1.2). The social variables were gender, age, social class (in the 1985 version only), and mathematics qualifications (exams passed, level and type). The affective variables, other than maths anxiety (see below), were: confidence in maths - both in terms of self-rating and expectations of difficulties with maths at the Polytechnic; use of numbers - in everyday life and at work; and difficulties with maths - in everyday life, work and previous courses.

The "Performance Scale" included questions in both school maths (SM) and numeracy / practical maths (PM) categories. This was based on the N1 view of numeracy's distinction between the two, using the overt context (wording) of the problems attempted. Both the school maths and the practical maths questions can be classified by the mathematical topics represented. The PM can also be classified by the practical context specified, the main ones being spending money (6 questions) and interpreting opinion poll results (2 questions); these were considered to be "gender-fair" (see APPENDIX Q4).

The Situational Attitude Scale (SAS) aimed to reproduce a sufficient number of items from both of Rounds and Hendel's dimensions of maths anxiety, maths test / course anxiety (TA) (NOTE 8) and numerical anxiety (NA), in order to tap maths anxiety in academic contexts and numerate anxiety in practical contexts in a valid and reliable way. It also included items on general anxiety (GA) and state anxiety. The major differences between the set of MARS items in the Polytechnic questionnaire and that used in the US research (Sec. 3.3) were: (i) we used 26 maths anxiety items instead of 98; and (ii) we used a symmetric 7-point scale of responses, rather than an asymmetric 5-point scale.

APPENDIX Q4 gives more detail about the questions used as indicators for the variables included in the conceptual map (see sec. 4.1.2). For clarity of exposition, it also describes a number of the decisions made about coding - though these may have been made after the fieldwork stage of the research (described in Sec.4.3).

4.3 <u>Fieldwork</u>

The questionnaire pilot work, the completion of the main questionnaire, and issues of non-response are considered here, since they all relate to fieldwork phases of the survey.

4.3.1 Pilot tests of the questionnaire

The three versions of the questionnaire were given pilot runs on a total of 25 people over the three years. Those participating included students at the Polytechnic, colleagues, friends, and young people of college age living in my community (Crouch End, North London). Since the timing of the completion of the questionnaire had to be very carefully planned, I asked them to record the time taken for each section, as well as giving feedback on the questionnaire. They suggested revisions to the layout (e.g. reproducing the seven categories of response to the SAS at the top of the second page), to the ordering (e.g. not to have the age question first, as it might be disconcerting to some repondents), and to the wording (e.g. replacing missing words). Some suggestions were not able to be taken on board; for example, several pilot respondents insisted on the need for a more specific description of the context for some SAS items before they could answer: "it depends", they said. (NOTE 9) Another queried the clarity and coherence of the distinction between "work" and "everyday life" in the usefulness and diffculty questions. It will be important to keep these limitations in mind when interpreting the questionnaire results.

4.3.2 The completion of the questionnaire

I aimed to ask for 20 minutes at the end of the first or second lecture in each of BASS Methods & Models Maths, the DipHE QM100, and (from 1984) CM100. In the event, this was agreed by the colleagues lecturing in QM100 and CM100, but not for BASS Maths; this was on the grounds that such a questionnaire, including a part likely to be perceived as a test, might distress some students, and might therefore interfere with the strategy of reassuring incoming students about their ability to do maths successfully, in "the Methods & Models way".

Therefore, for BASS students, the questionnaire was introduced at the end of the first Psychology lecture (by Peter Sneddon) in the first week of teaching, as an example of social psychology research. For QM100, it was introduced at the end of a (two-hour) lecture (by IR, a member of the School of Mathematics), during the first or second week, as part of research being done by a tutor (myself) of an advanced-level module (QM390: Social Research Methods). For CM100 (Communication Studies), it was introduced at the end of of the first (two-hour) lecture (by TW, a member of the School of Sociology), during the first or second week, as related to research on a particular mode of communication (numerate, symbolic).

In each case, Peter Sneddon (for BASS Psychology), or myself (for QM100 and CM100) introduced the questionnaire with a standard set of introductory remarks. In particular, the students were reassured that their performance on the questionnaire would not affect their position on the course - because the questionnaires would be anonymised. (Transcripts of the "scripts" I used in 1983 / 1984 and in 1985 are given in APPENDICES Q5 and Q6.) We then asked the students to complete the Experience Scale, but not to start the Performance Scale yet. After 4 or 5 minutes (based on estimates from the pilot for that year), we asked them to leave the Experience Scale (but to return to finish it if need be), and to go on to the Performance Scale. Here they were to try to do as many items - in order - as possible in the allowed time of 10 minutes, but they were not expected to complete the whole scale. After 10 minutes, we asked them to take as long as they wished to complete the Situational Attitude Scale, and to return to the Experience Scale, if necessary, but not to return to the Performance Scale.

On one occasion (BASS 1984), a few students were seen to try to return to completing the Performance Scale, and were asked to stop. Once, a student protested about being asked for her parents' occupations (BASS 1985). Another student asked whether we always gave people such a rude shock on the first day (QM100 1985). However, on all occasions, the overwhelming majority - if not all - of the questionnaires were completed and returned by the end of the lecture period, without apparent distress to the vast majority.

4.3.3 Non-response

Nevertheless, I must raise the issue of non-response, and the related issue of the representativeness of the samples.

The samples were not completely representative of the populations of all students on the relevant courses for several reasons. First, since it was early in the term, and the students' choices of course or of modules (on the DipHE), were not yet finalised, the list of students registered for the course or module was not precisely representative of the group of students who would eventually be registered for it. Second, some non-attendance of registered students at the particular lecture where the questionnaire was circulated was to be expected. Third, some students at the lecture might possibly have refused to complete the questionnaire, or to return the completed questionnaire. (There were several cases of the latter, at the BASS 1985 presentation of the questionnaire.)

The first problem - the possibility that the final set of entrants to each course would differ slightly from that enrolled in the first week or two - was unlikely to be strongly related to the focus of the research and therefore unlikely to be very important, whatever the numbers of students involved. (NOTE 10) Similarly, the second problem - failure to contact students because of their non-attendance at the relevant lecture - was also presumably only randomly related to the focus of the survey - at least for the BASS group (where the questionnaire was completed in a Psychology lecture), and for CM100. The third problem - non-cooperation of some attending students - was likely to be systematically related to the material of the survey - but, as long as it formed a relatively small part of the non-response, we can be fairly confident that the samples could be considered as reasonably representative of the eight working populations as defined (see sec. 4.2.1). (NOTE 11)

4.4 Summary

The conceptual map for the questionnaire survey part of this study was based on a modified version of Fennema's generic model (see Fig. 4.1). It includes:

- basic social structural variables of gender, age, and social class, as well as qualification (exams passed) in maths;
- outcome variables of performance and maths anxiety; and
- intervening affective variables of confidence, perceived usefulness, and perceived difficulty.

The importance of the context was emphasised by attempting to distinguish items appropriate for measuring performance in school maths (SM) from those for maths in a practical context (PM); this was based on the N1 view of numeracy (Sec. 2.1). In addition, I aimed to distinguish maths test / course anxiety (TA) from numerical anxiety (NA) related to practical contexts, as had been done by Rounds and Hendel

(1980) and other researchers; as well, measures of general anxiety (GA) were included. Also, contexts for usefulness and difficulty were distinguished as "work", "everyday", and "academic" (the latter for difficulty only).

A number of research questions and hypotheses were formulated for investigation in the survey. The main issues were:
(1) a comparison of the levels of performance in numeracy in the Polytechnic sample with those in the ACACE survey (discussed in sec. 2.2.1);
(2) an assessment of the adequacy of the specification of different contexts of performance, by investigating the inter-relationship of the school maths and practical maths performance scores;
(3) an assessment of the adequacy of the specification of different contexts of maths anxiety, by investigating the dimensionality of the MARS maths anxiety scale as used here;
(4) whether any uncontrolled gender differences found in performance and in maths anxiety would hold up when other variables (especially qualification in maths and age) are controlled for;
(5) whether any social class differences, controlled or uncontrolled, would be found; and
(6) whether the relationship between performance and maths anxiety (both specified as to school or practical context) could be described simply as a (linear) negative correlation - indicating a simply debilitating effect of anxiety, or as an "inverted U" (quadratic) relationship - suggesting that certain levels of anxiety might be facilitating.

The institutional setting decided on for the study was a Polytechnic with a substantial number of mature students. The samples (total size almost 1000) were the entrants for 1983, 1984 and 1985 to the BA Social Science and to the DipHE courses where Mathematics (or Quantitative Methods) were compulsory, along with control groups where the majority were not studying Maths or QM. The set of completed questionnaires was judged to be acceptably representative of the working populations defined.

CHAPTER 5

ANALYSIS OF THE QUESTIONNAIRE RESULTS - OVERALL SUMMARIES

... data analysis [...] is just like telling a story ...
(Scaglion, 1985, p.152)

In this chapter, I present some of the results from the Polytechnic survey. The analysis will be guided by the research questions and hypotheses set down in the previous chapter, especially the main issues highlighted at the end of it:

(1) comparisons of the <u>levels of performance</u> in the "Poly(technic)" sample with those of the national (ACACE) sample to ascertain whether the expected superiority of the Poly sample would be observed;

(2) assessing the extent to which the <u>context of performance</u> could be adequately specified within the questionnaire, by attempting to distinguish school maths and practical maths items in terms of the wording, plus diagrams etc.;

(3) the extent to which the <u>context of maths anxiety</u> could be adequately specified within the questionnaire, by using the distinction between numerical anxiety and maths test anxiety (which distinction will also be assessed in more detail in Sec. 6.1);

(4) <u>gender differences</u>, especially in performance and maths anxiety, both uncontrolled and controlling for age and qualification in maths;

(5) differences related both to <u>parents' social class</u> and to the student's <u>own social class</u> (where available), again

especially in performance and maths anxiety; and
(6) investigating the quality of the relationship between performance (cognitive) and maths anxiety (affective) - simply debilitating, or sometimes debilitating and sometimes facilitating? - through examining the shape of the relationship between the indicators - linear or quadratic?

Most of my results here will be presented in the form of uncontrolled differences of means (or proportions) or bivariate correlations, as were those of many of the studies reviewed in Chs. 2 and 3. In the next chapter, these relationships will be reconsidered in a framework that allows a more adequate use of controls, i.e. mathematical / statistical modelling.

I begin by describing results for the eight samples considered separately.

5.1 Profiles of the Samples

In this section, profiles of the Polytechnic samples are briefly discussed for the basic variables of the study: the social variables; intervening affective variables; and the outcomes, including performance in school maths (PERFS), performance in practical maths (PERFP), maths test anxiety (TA) and numerical anxiety (NA). Further details are given in APPENDIX R5.

It will be recalled that in each year, there were samples from the BA Social Science (BASS) and the Diploma in Higher Education (DHE) (see sec. 4.2.1). The DHE samples included all those students taking QM100 (the Quantitative Methods Basic Module) in 1983, and those students taking both QM100 and CM100 (Communications Studies Basic Module) in 1984 and 1985. Thus data are presented for all eight subsamples; see Tables 5.1(a), 5.1(b) and 5.1(c).

The three cohorts seem to have been increasingly better qualified over the period 1983 to 1985, with 41%, 43% and

52% respectively having passed O- or A-level maths (or an equivalent). This was to be expected, with the increasing competition among school-leavers for places in higher education over this period.

For outcomes, seven of the eight subsamples averaged between 8.1 and 8.6 questions correct out of 10 on school maths performance (PERFS), the exception being the DHE QM subsample in 1985 at 7.8 questions; part of the explanation may be this subsample's relatively low maths qualifications and higher average age. For numeracy / practical maths performance (PM), all eight subsamples scored between 8.5 and 9.2 questions out of 12. I compare the PM performance results of the Polytechnic sample with those of the ACACE national sample (see sec.2.2.1) in Sec.5.2.

For maths anxiety, the average score for the numerical anxiety (NA) items was around point 3 on the scale (meant to indicate "fairly relaxed" - see APPENDIX Q1), and, for maths test anxiety (TA) items, it was just over scale point 4 (the neutral point: "neither relaxed nor anxious"). It was not possible to compare my results with any study of the public, nor with any of the previous studies of students, since the latter had all been done in the USA and used somewhat different versions of the anxiety scale (see sec.4.1.3(c)).

Several conclusions can be drawn. There does not seem to have been any substantial disparity among the samples that would argue against the pooling of the eight samples for the rest of the data analysis (except that for confidence (Poly expectations) (CONFEP), which was excluded from the analysis - see APPENDIX R5). Nevertheless, it was clear that allowance needed to be made for cohort (year) and course differences in subsequent analysis. And, finally, of course, the differences reported in this chapter might well change substantially with gender, social class, age and qualification in maths controlled for. Secs. 5.5 and 5.6, and APPENDICES R6 to R9 discuss uncontrolled differences related to these factors, and Ch. 6 will present several models of the combined effects of all these factors.

But first, I consider issues to do with the levels and contexts of performance.

5.2 Levels of performance

In order to appreciate further the meanings of the results for performance presented in Sec. 5.1, it is useful to compare the Polytechnic results with those from a national survey. The most suitable baseline for comparison was the set of results from the ACACE survey done for Cockcroft in 1981 (see Sec. 2.2). I expected the Polytechnic students to perform substantially better than the adults in the general population; see the discussion of hypotheses in Sec. 4.1.3.

5.2.1 Comparison of the Polytechnic results with the national sample

The Mathematics Performance Scale in the Polytechnic questionnaire used all but one of the ACACE questions. (see sec. 4.2.2). The reasons for my expectation that the Polytechnic students would perform substantially better can be seen when we compare the profiles of basic characteristics of the two samples; see Table 5.2.

The Polytechnic students were younger and appeared to be more middle class (using parents' occupational class at least) (NOTE 3). Both of these characteristics were associated with higher performance on the national survey (see sec. 2.3.1). So too was gender - men scored higher than women - but there was a slightly lower proportion of men in the Polytechnic sample. In addition, the Polytechnic students' educational qualifications (in terms of number of A levels) were estimated to be much better.

Thus, when we compare the total questions correct on average for the National (ACACE) and the Polytechnic samples, it is not surprising that we find a substantial superiority - of one full question out of ten - in favour of the Polytechnic students; see Table 5.3.

I also considered differences on particular questions, since it seemed reasonable to see the different questions as indicators of a range of practical numerical skills. For the reasons given above, I expected the Polytechnic sample to be superior to the national on each individual question. Indeed, when we look at the results for individual questions in Table 5.3, we find that the Polytechnic results were superior on all questions - except for two:
Qu. 3 (ACACE) / Qu. 18 (Poly) about the amount of a 10% tip; and
Qu. 10 (ACACE) / Qu. 6 (Poly) on the (fractional) amount you would expect to pay in a shop advertising "25% off marked prices".
Figs. 5.1 (a) and (b) show the two pairs of forms of questions separately.

Before considering these two particular questions, it would be useful to look more closely at the different contexts of the two surveys - which, along with the differing characteristics of respondents, might help to explain differences in performance on these two surveys.

In terms of setting, the National Survey was based on street interviewing in Feb. 1981. The numeracy questions formed part of the Gallup Social Survey. The Polytechnic Survey questionnaires were distributed at the end of eight mass lectures (of 50 to 200 students) in Psychology, Communication Studies and Quantitative Methods (for BASS, DipHE/CM and DipHE/QM groups respectively) in the Polytechnic itself; this was during the first or second week of the students' course (in Sept. or Oct. of 1983, 1984 and 1985); see sec. 4.3.2 for a fuller description of the setting. Within the Polytechnic questionnaire, the performance questions were preceded by the Experience Scale, and followed by the Situational Attitude Scale (maths anxiety items). It is important to note that the Performance Scale was timed (10 minutes).

In terms of survey administration, the Polytechnic questionnaire was completed by the student, whereas the national questionnaire was administered by the interviewer. This difference could have made a substantial difference to the results on certain questions, where the interviewers might have provided "cues"; such cues, often subconsciously emitted and received, can sometimes help the respondent to formulate an answer, or to correct a slightly erroneous answer (see below). It is even possible that the interviewers may have provided more explicit helping - as they would have done for other sorts of responses within the same questionnaire. It is worth remarking that performance questions would be a new sort of task for interviewers used to market research and opinion polling: a precise numerical answer was sought, and was meant to be produced without the usual sorts of prompts and probes involved in eliciting product or policy preferences. (NOTE 4)

I now look at each pair of questions in turn.

(a) Qu. 10 (National) / Qu. 6 (Polytechnic)

These two questions concerned a 25% reduction in price; for their formats, see Fig.5.1(a). If we consider the range of actual answers given by members of the two samples in Table 5.4(a), it can be seen that the percentage correct was the same in both surveys. However, this question was one of the three least well answered on the national survey, and had the <u>lowest</u> percentage of correct answers on the Polytechnic survey. A high percentage of Polytechnic respondents, almost a third, were coded as giving the (wrong) answer "a quarter". Both forms of the question appear to have been "tricky", in that both "three quarters" (correct) and "a quarter" were offered as answers, whereas neither survey <u>offered</u> the answer "a quarter off". However, ACACE interviewers allowed this answer, and recorded it for 7% of respondents. In contrast, it was much more difficult for a student to respond this way to the Polytechnic form of the question, since the Polytechnic survey used a written self-completion format, and there were no "cues" from an interviewer. For this question, it is conceivable that one of the national survey respondents who answered "a quarter" may have realised from the interviewer's response that that was not quite right and may have added "... off". Admittedly, the precise prevalence and effect of such "cues"and responses is always hard to assess.

(b) Qu. 3 (National) / Qu. 18 (Polytechnic)

These two questions concerned a 10% tip; for their formats, see Fig.5.1(b). Here, the ACACE question presented the costs of four items summed to a total on what resembled a restaurant bill, whereas the Polytechnic question presented only a total amount as part of the problem statement. This apparently small difference may have had a significant impact on the way respondents perceived the questions. The form of the ACACE question may have allowed respondents to "recall" the activity of eating out at a restaurant, including paying the bill - whereas the Polytechnic question may simply have reminded them of school maths questions (perhaps in a test situation). Again it is difficult to know for certain.

However, some support for this idea is given by the actual responses to the questions on the two surveys; see Table 5.4(b). Perhaps the most striking feature of this table is the substantial proportion of the Polytechnic sample - about one student in seven - who gave the answer "37.2p". This is just the sort of answer we would expect from those who have "recalled" school maths in responding to the question, rather than the sort of practical situation that Brigid Sewell and the ACACE wished to evoke. (NOTE 5) Again it is also the sort of answer that may have been revised in the national survey, as a result of cues from the interviewer. It is also noticeable that the proportion of students not answering was slightly greater amongst the Polytechnic students than in the national sample. This may be related to the fact that the tipping question was presented towards the end of the Performance Scale (Qu. 18 out of 24), and some of the students appeared to begin to run out of time at that point. (NOTE 8)

These comparisons of responses to pairs of questions, which differ in terms of question format (NOTE 6), and/or in terms of setting and methods of eliciting responses, show the potential influence of such factors on responses. (NOTE 7)

5.2.2 The possibility of standardised comparisons

The discussion above suggests that, in addition to differences based on sample differences, there would be differences due to the two surveys' settings, their methods of eliciting responses, and question format - and that it would be difficult to estimate the likely effect of such differences. In the light of this, I judged that it would not be worth making adjustments for gender, age and social class differences in an attempt to produce precise comparisons between the national and Polytechnic performance scores - because there would still be the effects of these other types of differences that would not be allowed for.

Indeed, these different settings, methods of eliciting responses, and question formats are the sorts of features that go to make up the context of responses to questions such as these. I shall discuss them further when I attempt to broaden the idea of context in Ch. 7.

5.3 Performance on "School Maths" vs. "Practical Maths"

5.3.1 Overall scores

There was little point in comparing the overall levels of performance in the school maths area (PERFS) and in the practical maths area (PERFP), as we cannot be sure of the relative difficulty levels of questions on the two subscales. In addition, the time limit on the completion of the Performance Scale could be expected to take a greater toll on the PERFP score: of the last 7 questions included in either subscale score, all but one (Qu.16) were included in the PM subscale. (NOTE 8)

However, as indicated in the discussion of research questions and hypotheses in sec. 4.1.3 (b), we would expect the inter-correlation between the PERFS and PERFP subscale scores to be substantially less than 1, if the two were "measuring different things". And, of course, the two subscales were constructed to reflect <u>different contexts</u> in their wording, use of diagrams, etc. For example, nine of the questions produced for the national survey of "basic mathematical skills called for in everyday situations" (ACACE, 1982, p.18) were used as the basis for my practical maths scale (see sec. 4.2.2).

On the other hand, there were several reasons why the correlation between the PERFS and PERFP scores might turn out to be fairly high. First, when the questions on the two subscales are actually inspected, the practical maths items appear very similar to the sorts of questions done at school - and therefore PERFP may not have measured anything very different from PERFS. Second, the two sets of questions were completed at the same time and under the same conditions; indeed the school maths and the practical maths questions were roughly alternated in my performance scale.

We could check this issue using empirical evidence in at least two ways: first, by examining the correlation between PERFS and PERFP; and second, by comparing the correlations of each of the two performance subscales with <u>other</u> variables. The second approach can be pursued by comparing the models produced or PERFS and PERFP in Ch.6 (and also by using the data presented in APPENDIX R10). For the first approach, the correlation between school maths performance, PERFS, and practical maths performance, PERFP, was 0.55 for the whole sample (n= 935). Since this value is only moderately large (it produces a value of R-squared only just over 30%), this does not give strong support to the idea that PERFS and PERFP are measuring the same thing.

Of course, even if the two subscales were measuring the same thing, because of random measurement error, the correlation between PERFS and PERFP would not be expected to be even very close to +1. Further, there might be a systematic lack of reliability if scores would change with a re-ordering of the questions, or with a removal of the time limit; these changes might also attenuate the correlation. (NOTE 9) Nevertheless, this result gives some support - but only limited - to the idea that PERFS and PERFP were measuring different things. Since much of the discussion in Ch.7 is in effect about the validity of these sorts of indicators for PERFP in particular, I shall return to these issues.

5.3.2 Sets of questions

Performance on the ten questions that had previously been used in the national (ACACE) survey has been discussed in Sec. 5.2. The success rates for all the questions in the Polytechnic Performance scale are given in APPENDIX R4. I begin by comparing a set of four practical maths items (also used by ACACE), each involving one of the four basic operations, with two sets of school maths items of different types; see Table 5.5.

In general the success rates on these items were high, as would be expected, with the addition questions - but not the subtractions - slightly higher than those on multiplication and division. When we look at the subtraction questions, however, it can be seen why Qus. 5 and 8 might have been more difficult than the others, since they involved decimals.

Surprisingly, the practical money maths questions in Table 5.5 had a slightly lower success rate than the school maths / arithmetic questions - except for the subtractions. This would be contrary to the expectation based on the APU's ideas that the money context "helps" performance (see sec.

2.2.3) - but the three "surprising" differences were not large. The other difference may indeed suggest that 50p is easier to handle than .5 in subtraction.

These findings tend to call into question either the idea that a different, more "practical", context was established by changing the wording of the questions - or the idea that such a context would help performance - or both.

5.4 Dimensions of Anxiety: Initial Considerations

In Ch.3, the idea of representing anxiety in different contexts as different dimensions of anxiety was discussed. This section will examine questions to do with the dimensions of anxiety, using the inter-correlations between various subscales and indicators taken from the questions on anxiety and confidence. The 26 items measuring maths anxiety, based on the MARS (see Sec. 3.3), will be considered in more detail in Sec. 6.1.

We can separate the set of indicators for anxiety and confidence into:

(a) "trait" mathematics anxiety variables (NOTE 10):

MA = average score on 26 MARS-based items

TA = average of 13 MARS items called "maths test anxiety"

NA = average of 13 MARS items called "numerical anxiety"

MTA3 = average of 3 TA items, meant to parallel ETA (below)

(b) general anxiety variables:

GA = average score on 10 constructed items

ETA = average of 3 GA items, constructed to measure "English test / course anxiety"

(c) "state" mathematics anxiety variables (NOTE 10):

MA37 = item constructed to measure feelings about "doing this questionnaire"

(d) confidence variable:

CONFSR = average score on 6 items constructed to measure self-rating of "capability" in areas of basic maths.

A number of questions indicated in sec. 4.1.3 (d) can be

expanded here as follows:
(1) Are maths test anxiety, TA, and numerical anxiety, NA, measuring the same type (or context) of anxiety?
(2) Are TA and NA measuring a different type of anxiety from general anxiety, GA?
(3) Are English test anxiety, ETA, and the subset of 3 items of TA, MTA3, measuring the same type of "academic" anxiety?
(4) How does "state" maths anxiety, MA37, relate to "trait" maths anxiety, MA ?
(5) How does CONFSR (confident self-rating) relate to TA and NA?

Here I expected each pair of variables mentioned in questions (1) to (4) to be measuring something different to a greater or lesser extent - as indicated by a relatively low value of the correlation coefficient. For question (5), I expected the correlation between confidence and the two types of maths anxiety to be high and negative.

(1) TA and NA were moderately to highly correlated ($r = .68$). This suggested that they were measuring two dimensions of maths anxiety that were moderately highly related, but there was still a substantial amount of variation in either one dimension that was not associated with the other. This suggested that a factor analysis of the 26 items used was likely to produce two or more uncorrelated factors (see Sec. 6.1).

(2) TA and NA seemed likely to be measuring a different sort of anxiety from GA, as shown from the low to moderate correlations between them: $r(TA, GA) = .34$ and $r(NA, GA) = .52$. The larger correlation of general anxiety with numerical anxiety than with maths test anxiety suggested that NA might indeed be tapping anxiety related to practical contexts, since the contexts of the GA items were also practical, except for the three items aiming to measure what might be called "English test / course anxiety" (ETA).

(3) ETA and MTA3, based on three items which were based on mathematics but otherwise identical, did not appear to be

measuring the same sort of "academic" or test anxiety, since the inter-correlation was only r = .39. This finding, though based on scales which included only three items each, suggests that test anxiety - long treated as relatively _general_ in the psychological literature (see Sec.3.2) - may well be _specific_ to particular academic subjects.

(4) The measure of "state" maths anxiety, MA37, and the overall measure of "trait" maths anxiety, MA, correlated at a moderate level with r = .54. This gives some support to the idea that the two indicators may be measuring different kinds of anxiety, as suggested by the literature. (NOTE 10)

(5) The correlation of CONFSR (confident self-rating) with the two dimensions of MA was higher for TA than for NA: r = -.58 compared with r = -.46. This was to be expected, since CONFSR refers to capability in _school maths_ topics, and TA refers to _maths test / course_ anxiety.

5.5 Gender Differences in Performance and Affect

In this section, results are presented which relate to hypotheses about gender differences, discussed in sec. 4.1.2(e). A summary of the hypotheses investigated, the observed values for female and male subsamples, and the uncontrolled gender differences, are given in Table 5.6.

For school maths performance, PERFS, and practical maths performance, PERFP, the results show higher scores for men on these particular measures, in these particular samples - before controls were used; the sample estimates of differences were about 3/4 and 1/2 of a question for PERFS and PERFP, respectively, both statistically significant ($p<.001$). More detail is given in APPENDIX R6. As discussed in sec. 4.1.3, the observation of such gender differences in level of school maths and practical maths performance might have been dependent on differences in qualifications and/or differences in age. This will be discussed in sec.5.5.1 below.

The differences in maths test / course anxiety, TA, and numerical anxiety, NA, were in the expected direction - i.e. women reported higher levels of anxiety than men. However, although both differences were statistically significant ($p<.001$), they were not what I here call substantial: that is, they amounted to no more than 1/2 and 1/4 of a scale point (on a 7-point scale) for TA and NA respectively. Nor were the scores indicative of particularly high anxiety: for TA, the men averaged around "neither relaxed nor anxious", while the women averaged midway between that scale point and "a little anxious"; for NA, the women averaged a little more than, and the men a little less than, the scale point corresponding to "fairly relaxed".

Of the six affective variables, only confident self-rating in school maths (CONFSR) showed statistically significant differences in favour of men; see APPENDIX R6 for more detail. The other five affective variables, measuring usefulness and difficulty of maths / numbers in different contexts (viz. DFSM, DFED, DFWK, USED, and USWK) were each based on one question only: this might have led to problems of reliability and also of lack of discrimination. Even the one difference clearly expected, in difficulties in earlier maths courses (DFSM), did not lead to a statistically significant result. For these reasons, in each of the remaining sections of this chapter, only those indicators that figured clearly in one of the hypotheses will be examined.

When we consider qualification in maths, the difference in percentages of males and females who had passed O-level or A-level Maths, which was 13% (54%-41%) - moderately substantial, as expected. This difference seems to have resulted largely from the fact that the percentage of men who had passed O-level maths was 10% higher than that amongst women, and the percentage who had done CSE was 6% lower. This would seem to support claims made in the literature (before the advent of GCSE exams) that there was a greater tendency for boys to be put in for O-level Maths, and for girls to be put in for CSE (e.g. Walden and Walkerdine, 1985). This discussion reinforces the importance of controlling for qualification in maths, as well as for age (NOTE 10a), when considering gender differences in performance in this sample.

5.5.1 Gender differences in performance with controls for age and qualification in maths

I examined gender differences in performance while controlling for age and qualification in maths, in two ways. First, by examining the mean performance scores for the subgroups defined by the possible combinations of values on gender, qualification and age: 2 genders x 2 levels of qualification x 3 age groups, or 12 combinations in all. Second, by by modelling the relationships, using analysis of variance, or multiple regression, which would simultaneously control for all the variables entered into the model.

The results of examining the mean performance scores are shown in Figs. 5.3(a) and 5.3(b) for PERFS, school maths performance, and for PERFP, practical maths performance. As a rough summary, for both measures, the highest score was for young, high-qualified (O- or A-level maths) males - though they shared this position with older (25+), high-qualified males for PERFS. The lowest score for both measures was for intermediate-aged (21-24), low-qualified females - though they shared this position with older (25+) low-qualified females for PERFS. Indeed, overall, for both PERFS and PERFP, high qualifications in maths appear to have been an advantage for all age / gender groups. And being young (18-20) was also generally a substantial advantage, but the patterns of difference between the intermediate (21-24) and the older (25+) groups were more complex.

From these graphs it is clear that there are "interaction effects" among gender, age and qualification in maths for both Sm and PM performance. This can be seen from the fact that the lines joining the male and female performance levels for each subgroup are not parallel, suggesting that the "advantage" from being male is not the same for the groups differing on age and qualification in maths. The exact form of the interaction will be confirmed in the discussion of the modelling in Ch.6. (NOTE 11)

The second stategy, that of statistical modelling, is discussed in Ch.6. (NOTE 11a)

5.6 Social Class Differences in Performance and Affect

In this section, I present a summary of results related to research questions and hypotheses about social class differences, discussed in sec. 4.1.2(f); these are based on data from the 1985 samples (n = 291) only. For further details, see APPENDIX R7.

In the questionnaire, students were asked to report their father's and mother's occupation at the stage of begining secondary school, and their own most recent full-time occupation before joining the Polytechnic. On this basis, indicators for social class were assigned - SCF, SCM, and SCS respectively. In preparation for analysis, several decisions were made. For all three occupations, the Registrar General's categories were collapsed into "non-manual" (RG's categories I, II and III-NM) or "manual". For establishing a joint "parental" occupational class (SCP), a "symmetric" categorisation was used: parental occupation was middle class (MC) if both parents (or the only parent categorised) had non-manual occupations, working class (WC) if both parents had manual occupations, and mixed otherwise. Finally, because of the substantial amount of mobility evident in Table 5.7, I decided not to aggrgate SCP and the student's own occupation (SCS). For further details, see APPENDIX R7.

Considering parental occupation differences first, only for school maths performance for practical maths performance were the results in the expected direction: students with MC parents scored higher than WC. But the differences were not substantial (and not statistically significant). For maths test anxiety and numerical anxiety, the parental occupation differences were in the opposite direction to that expected.

In an examination of interaction effects between gender and (parental) social class (sec. 4.1.3(e)) - see Table 5.9, only for school maths performance was there a substantially larger parental occupation difference between MC and WC for women than for men, and it was at most on the borderline of statistical significance; see APPENDIX R7. In fact what is most striking about Table 5.9 is the way that gender differences were generally much larger than parental occupation differences. The validity of this impression can be assessed further when we look at the modelling of performance in Ch. 6.

For student's own occupation, in practical maths performance, the difference between students whose last full-time work had been coded as non-manual (NM) and those with manual (MAN) work was in the <u>opposite</u> direction to that expected; i.e. it was in favour of those in the MAN category. The latter was also true for school maths performance, though there had not been a clear expectation for that variable. When we consider anxiety variables it can be seen from Table 5.10 that differences in numerical anxiety (NA), and in maths test anxiety, were not substantial, and again they were in the <u>opposite</u> direction to that expected (for NA).

It will be especially useful to re-examine these social class differences, while controlling for other basic variables such as gender, age and qualification in maths, in Ch.6. The SCS differences need to be interpreted with especial care because of problems of validity (the students were indicating what had been their occupation at a time which for most was very early in their careers) and of reliability (there were risks of coding errors because of the paucity of information given by some respondents).

5.7 Relationships between Performance and Maths Anxiety

Here I reasoned that, if the methods of producing measures of performance-in-context, and of anxiety-in-context, were valid, then certain results would be expected. The correlation of school maths performance (PERFS) with maths test anxiety (TA) should be greater than that with numerical anxiety (NA), and the correlation of practical maths anxiety (PERFP) with NA should be greater than that with TA; see sec. 4.1.3(h). In Table 5.13, the simple linear (Pearson) correlation coefficients of each of the performance variables with the two maths anxiety dimensions were negative, as predicted, and statistically significant. (NOTE 16) In addition, the correlation of PERFS, with TA, was substantially higher that its correlation with NA, as expected. However, the correlation of PERFP, with NA was only very slightly higher than its correlation with TA.

The literature review in Ch.3 had suggested that the relationships between performance and maths anxiety might be of an "inverted U" form, i.e. quadratic. Figs. 5.4(a) and (b) show the relationship between PERFS and TA for each decile of the distribution of TA, and that for PERFP and NA, respectively. (NOTE 17) These Figures suggest that both the uncontrolled relationship between school maths performance and maths test anxiety, on the one hand, and that between practical maths performance and numerical anxiety, on the other, were negative and reasonably linear, rather than quadratic. We shall check whether this simpler version of the relationships holds up in the statistical modelling of the performance variables in Ch.6.

Relationships between performance and other affective variables, including confidence, and relationships among the affective variables are discussed in APPENDIX R10.

5.8 Summary

The analysis of results was based on six major issues, highlighted at the beginning of the chapter. For the first issue, it was expected that the Polytechnic students would score higher overall on the numeracy questions than the ACACE national sample. They did. The Polytechnic students also scored higher on individual questions, with the exception of two where special features operated, in an instructive way. These related to the differing contexts, namely, the settings and the methods of administering the questionnaires, and to differences in question format. The latter may have allowed the national sample to "call up" the activity of, say, eating out - in the case of the question on calculating a 10% tip for what was presented as a restaurant bill - whereas the Polytechnic students may have tended instead to call up school maths, in response to the slightly differently presented question, and to the performance scale questions generally.

The second and third issues relate to assessing the strategy for capturing the context of performance, cognition and affect. This strategy aims to differentiate the contexts of performance items, and of maths anxiety (or other affective) items in terms of the wording of the items themselves. However, the support from the data for the validity of this strategy is at best limited. The observed relationship between school maths and practical maths performance subscales - only a moderate positive correlation - was inconclusive: these two indicators may have been measuring different things - or they may have been measuring "the same thing", with a fair amount of unreliability.

The two dimensions of mathematics anxiety found in earlier research (e.g. Rounds and Hendel, 1980) - maths test / course anxiety and numerical anxiety - were also found to intercorrelate only moderately highly (and both showed low correlations with the general anxiety scale). This suggested that the factor analysis of the maths anxiety items would produce at least two dimensions (see Ch.6).

The fourth and fifth issues concerned gender differences in performance and maths anxiety, and social class differences for the same measures. The performance differences in favour of males that were expected on the basis of much of the literature reviewed were found for both measures of performance (SM and PM or numeracy). However, more of the males had successfully completed O- or A-level courses in maths, and so maths qualification, and also age, needed to be controlled for. Initial efforts to control for these two social variables suggested the existence of interaction effects, and hence the importance of the statistical modelling to be done in Ch.6.

In general, social class differences in performance were much smaller than gender differences, both for combined parental social (occupational) class, and for student's own occupation. It was only for parental social class that performance differences were in the expected direction (i.e. those with middle class parents higher than those with working class parents), and they were small (even before controlling for age and qualification in maths). However, both middle class and working class groups performed substantially better than those with "mixed" parental background; this suggested an area for possible attention in the interview, and/or in further research. For student's own occupation, the differences appeared to favour those whose last full-time occupation was manual, rather than non-manual; some of this apparent anomaly could be explained by the fact that the manual group included more males, was younger, and had more middle class parentage, but it also reaised questions about the validity and reliability of the student's own occupation measure.

Turning to now affective variables, there were gender differences for both maths anxiety measures (but not for general anxiety), and for confident self-rating in maths, as expected: women reported more anxiety, and less confidence. However, contrary to expectation, students with middle class parents scored <u>higher</u> (though not at statistically significant levels) in maths test anxiety and numerical anxiety. Maths anxiety differences related to student's own occupation again appeared insubstantial.

Turning now to the controlling variables, I summarise material presented in APPENDICES R8 and R9. Maths qualifications differences for school maths performance followed a hierarchical progression from those with no qualifications at all, to those with CSE, to those with O-level, to the highest scores for those with A-level. A similar progression was followed for those affective variables related to school maths - namely maths test anxiety, confidence in school maths, and difficulties with previous maths courses. For practical maths performance, differences were observed only between those with O- or A-level maths and the rest, and qualification differences in numerical anxiety were negligible. For age, the scores in school maths performance for the 18-20 group were much higher than for the 21-24 and 25+ groups, the latter being about equal. For PERFP, practical maths performance however, the score for the intermediate group was much lower that the other two, even after controlling for numbers who reported having had a full-time job (or even a non-manual job) before joining the course. This suggested the need to use three age groups in the modelling of PERFP, even if two were sufficient for modelling PERFS (see Ch.6). Levels of reported maths anxiety (both dimensions) increased progressively over the three age groups, with the youngest (18-20s) reporting the lowest levels.

The sixth major issue related to relationship between performance and maths anxiety: is it simply debilitating, or is it facilitating at lower levels of anxiety, and debilitating at higher levels only? This relates to the shape of the relationship: negative and linear, or quadratic, an inverted U? The results so far supported the idea of a negative linear relationship between school maths performance and maths test / course anxiety, and a (less strong) one between practical maths performance and numerical anxiety. However, there was no support for an inverted U (quadratic) relationship at this stage, before controls were introduced. Confidence (self-rating in school maths topics) also showed substantial positive relationships with PERFS and (a lesser one) with PERFP. Of the other affective variables, only the measures of difficulty in using numbers in everyday life and in work had at all substantial correlations with the relevant performance variables.

The first issue discussed here, that of the comparison of the performance of Polytechnic students and the national sample on the ACACE questions has been addressed as fully as possible here. However, the ideas about the contexts of performance and of affect which I have begun to assess here (the second and third issues) have not received much support from the data (see above). They are also being called into question by the unexpectedly lower results for the Polytechnic students on two of the ten ACACE questions. One of the differences might be explained by the more "realistic" presentation of the national survey question using a facsimile of a restaurant bill: this could after all still be seen as a difference in "wording", broadly understood. But the other difference seemed to have been due to the different settings - street vs. lecture hall - and the different methods of administering the two surveys, including the timing of the Polytechnic performance questions. These sorts of considerations point the way to a richer notion of <u>context</u>, which will be discussed in Ch.7.

Meanwhile, the modelling exercises in Ch. 6 will return to the fourth, fifth and sixth isues addressed here. They will aim to give a fuller interpretation of gender and social class differences in performance, and in maths anxiety, while controlling for qualification in maths and age, and including interaction effects. The performance models will also re-examine the relationships between performance and maths anxiety, including the question of their shape.

CHAPTER 6

ANALYSIS OF THE QUESTIONNAIRE RESULTS - STATISTICAL MODELS

> The single most important influence on learning mathematics is studying mathematics....
>
> (Fennema, 1979, p.391)

In this chapter, I describe the use of two sorts of models in the analysis of the questionnaire data. These will be deployed in addressing issues (2) to (6) highlighted in the summary of Ch.4, and throughout Ch.5. (the discussion of issue (1) having been completed). Beginning with the third issue, factor analysis models are used to assess the division of the MARS maths anxiety items into maths test anxiety (TA) and numerical anxiety (NA) dimensions - as a way of capturing school and practical contexts of the anxiety - for the sets of items and for the sample of Polytechnic students used here; see Sec. 6.1.

Next, related to issues (4) and (5), multiple regression models are deployed with the aim of producing estimates of differences in both <u>maths anxiety</u> variables (as outcomes) related to gender and social class, controlling for age and qualification in maths; see Sec. 6.2. For the two main <u>performance</u> scores, school maths performance (PERFS) and practical maths performance (PERFP), I aimed to produce estimates of performance differences due again to gender and social class, controlling for qualification in maths and age. I further aimed to estimate effects due to anxiety (and to other affective variables); see Sec. 6.3.

This latter aim is related to issue (6) - whether anxiety has a straightforwardly debilitating effect on performance, or whether it might be facilitating at moderate levels, and debilitating only at higher levels. In modelling terms, this translates into the question: is the relationship between performance and anxiety negative and linear, or is it quadratic, in the shape of an "inverted U"? Issue (2) - whether the differing contexts of school maths and practical maths performance are adequately captured by the differently presented PERFS and PERFP items - is addressed in the summary of the chapter.

6.1 Dimensions of Mathematics Anxiety

Issue (3) in the questionnaire analysis concerns the way that the context of maths anxiety, and affect in general, is represented. In Sec. 5.4 we considered the correlation between the two dimensions of maths anxiety analysed by Rounds and Hendel (1980) - maths (course and) test anxiety and numerical anxiety, meant to relate to school and practical contexts, respectively - and found them to be only moderately highly correlated. This suggested that there might be two distinct dimensions, and hence two separate contexts, of "maths anxiety". Here I consider the question of the dimensionality of mathematics anxiety in a more fundamental way - using factor analysis to examine the pattern of correlations among the 26 items tapping (expressed) maths anxiety in the Polytechnic survey, based on the MARS (see sec. 4.2.2).

6.1.1 Factors of mathematics anxiety

First of all, I expected Rounds and Hendel's (1980) dimensions of "maths test / course anxiety" (TA) and "numerical anxiety" (NA) to be reproduced broadly in this study. A number of other researchers had produced similar dimensions; e.g. Brush (1978) and Resnick et al. (1982). As

for subdivisions of the original two main dimensions, Morris et al. (1978) divided maths course / test anxiety itself into three sub-dimensions:
- maths class anxiety,
- maths studying anxiety, and
- maths test anxiety. (See also sec. 3.3.2.)

Prior to beginning the factor analysis, I tentatively grouped the 26 MARS-based items into categories that seemed to relate to activities grounded in the same context, using the discussions above, and my own further ideas. First, I classified the 13 items categorised by Rounds and Hendel (1980) as maths course / test anxiety, using Morris et al.'s (1978) three subdivisions, and further dividing "maths class anxiety" into anxiety to do with being in maths classes and anxiety to do with choosing and thinking about courses, with the following results:

maths class anxiety - 6 items: Poly SAS Qus. 8, 9, 13, 18, 20, 23;

maths studying anxiety - no items in the Poly questionnaire;

maths evaluation anxiety - 3 items: Poly SAS Qus. 25, 31, 35; and

maths course anxiety - 4 items: Poly SAS Qus. 3, 4, 15, 28.

Further I was struck by the active, immediate character of the situation described in two of the maths class anxiety items, namely Qu. 18 - "Being asked a question by the teacher in a maths class" and Qu.23 - "Raising your hand in a maths class to ask a question" - as opposed to a passive situations described in the other four; e.g.

Qu. 13 - "Listening to a lecture in a maths class", or

Qu. 20 - "Sitting in a mathematics class and waiting for the teacher to arrive".

Next, I classified the 13 items categorised by Rounds and Hendel as numerical anxiety, on the basis, used by them, of whether the item referred to a situation involving "monetary decisions", to other "practical situations", or to the "use of arithmetic skills without a context" (1980, p.142). Again, I further divided the nine "money anxiety" items into those that referred to immediate exchange situations - e.g.

Qu.1: "Determining the amount of change you should get..." - and those that involved planning, usually on one's own - e.g. Qu.19: "Being responsible for keeping track of the amount of subscriptions collected for an organisation". This had the following results:

money, immediate exchange - 4 items: Poly SAS Qus. 1, 14, 22, 24;
money, planning - 5 items : Poly SAS Qus. 5, 17, 19, 27, 33;
other practical contexts - no items in the Poly questionnaire;
context unspecified - 4 items: Poly SAS Qus. 6, 10, 11, 30.

Thus I produced seven tentative categories of mathematics anxiety item - four nested within the maths course / test anxiety dimension of Rounds and Hendel, and three within their numerical anxiety dimension, as above. These can be regarded as a development of my hypotheses about the dimensions of maths anxiety (see Sec. 4.1.3) and are summarised in Table 6.1.

From this point onwards, a mathematics anxiety item from the Situational Attitude Scale of the Poly questionnaire will normally be preceded with a "T" or an "N", according to whether it was classified by Rounds and Hendel as a maths test anxiety, or a numerical anxiety item, respectively (see Appendix Q9). Thus, for example, Qu.24 - "Figuring out VAT at 15% on a purchase which costs more than one pound" becomes "N24".

6.1.2 Aims and techniques of factor analysis

The aim of factor analysis is to take a set of variables, say p of them, and to reduce the dimensionality of the set, say to $m < p$ underlying "factors". There has been a great deal of discussion, even controversy, especially within psychology and education about the methods to be used (Harman, 1976). There are two major stages to any factor analysis :

(i) extraction of a reduced m-dimensional "factor space" from the p-dimensional "variable space" (where $p < m$); and
(ii) rotation of the m-dimensional factor space, so that its underlying dimensions are more easily interpretable in psychological or educational terms.
In some analyses, these two stages are followed by :
(iii) estimation of scores on the factors for each individual case.

In the analysis here, because I was concerned to use the factor analysis to assess claims such as those in the previous subsection about the prominence of certain factors (NOTE 1), the first two stages were sufficient for my purposes.

(i) Extraction: Of the available methods, I chose to focus on three :
- Principal Axes (PFA)
- Maximum Likelihood / Canonical (MLFA)
- Alpha Factor Analysis (AFA).

All of these methods involve representing each of the p variable scores as a linear combination (or weighted sum) of scores on the m factors. The basic model is:

$$x_j = \sum l_{jk} \cdot f_k + e_j \qquad \text{over } k = 1,2,\ldots m$$

for each $j = 1,2,\ldots p$
with x_j = original variables
l_{jk} = factor loadings
f_k = factors
e_j = residuals

The original variables are sometimes scaled by their standard deviations, which leads to an analysis of the correlation matrix (R), rather than the covariance matrix (V). In the Principal Axes (PFA) method, it is normally R with "communalities" on the main diagonal that is factored; the communality of a variable is the part of its variance that is shared with the other variables measured, i.e. (1 - variance of e_j). On the other hand, both the Maximum

Likelihood (MLFA) method and Alpha Factor Analysis (AFA) normally use the covariance matrix V. However, the choice among the three methods of extraction is to some extent a technical issue (e.g. McDonald, 1970, pp. 11-15).

On the basis that it was desirable in practice to employ several different methods in order to see whether scaling assumptions and practices were important, I decided to use all three methods of extraction, and to retain only those factors that were obtained independently of method (Harris, 1967, but see also McDonald, 1970).

(ii) Rotation : The factor space may be rotated with factors that are orthogonal (uncorrelated) or "oblique" (correlated). Here, each of the factor solutions from (i) was subjected to one orthogonal rotation (varimax) and one oblique (direct oblimin with parameter = 0). These are the most commonly used rotations of each type, and they are also the rotations used by Rounds and Hendel (1980).

6.1.3 Results of the factor analyses

Four-factor, three-factor and two-factor analyses were done. Each analysis determined the number of factors, then extracted that number in three ways (PFA, MLFA, AFA). For each extraction, the resultant matrix of factor loadings (see the equation above) was rotated in two ways (varimax, oblimin), making six results in all. For each, the rotated matrix of factor loadings was examined to see which of the original variables (items) had a loading (correlation) of .4 or greater with each of the factors constructed; this is slightly more demanding than the usual criterion (factor loadings .3 or greater), and leads to a somewhat more simple structure for the results. Only those items that had acceptable loadings for the majority of the six results are considered in the discussion of each analysis below.

(a) The four-factor analysis

The first analysis chose the number of factors as equal to the number of latent roots of the correlation matrix, that were greater than or equal to one. Therefore, 4 factors were extracted. (NOTE 2)

For four of six results, the 4-factor analysis produced three interpretable common factors, and one factor that was basically specific. (Factor 4 had a substantial loading on only one "numerical anxiety, context unspecified" item (N6 - dividing ... in private with pencil and paper).) This suggested the analysis should be redone with 3 factors.

(b) The three-factor analysis

The analysis was redone, with 3 factors specified (corresponding to the three largest latent roots). Again, there were six results, based on 3 extractions (PFA, MLFA, AFA), each with two rotations (varimax and oblimin). For the full factor-loading matrices, see Tables 6.2(a), (b) and (c) and the summary in 6.2(d).

For the principal axis (PFA) and maximum likelihood methods (MLFA), almost all of the items loaded on one factor only, especially for the oblimin rotations. Thus, Factor 1 loaded on all the "maths evaluation" items (3) and "maths class, active" items (2). It was not surprising to find these two sets of items together - since they both referred to situations where there might be different sorts of evaluation, related to mathematics.

However, Factor 1 also loaded on N10 - "Having someone watch you as you total up a column of figures", and, for the varimax rotations, it also loaded on N24 (15% VAT) and N30 - "Being given a set of numerical problems... to solve on paper". It was somewhat surprising to find the two (of four) "numerical anxiety / unspecified context" items loading on a factor apparently concerned with contexts where evaluation might be going on. Yet both appeared to be very (school-)mathematical, and they implied an "other" who watches (N10) or who gives "problems" to be done on paper (N30). The inclusion of N24 was most interesting: though it appeared to relate to the money context, it mentioned percentages and included a somewhat artificial qualification ("a purchase that costs more than one pound"). Further, by 1983-85, when the questionnaires were answered, the Value Added Tax (VAT) was included in the prices in most shops and restaurants, and therefore younger students especially would not have had much experience with it. Apparently, the feelings brought up by this item had much in common with those experienced in evaluative situations to do with maths tests, courses and classes.

Factor 2 loaded on all "maths course anxiety" items (4) and all "maths class anxiety, passive" items (4). These are the remaining "maths test / course anxiety" items not included in Factor 1. Factor 3 loaded on all numerical anxiety items, except for N10 ("Having someone watch you ...")

For the alpha method (AFA), see Table 6.2(c). These results approached two factors, especially for the oblimin rotation. These were very similar to Rounds and Hendel's (1980) division into maths course / test anxiety (TA) and numerical anxiety (NA) items - except for the categorising of the three "maverick" numerical anxiety items mentioned in the previous paragraph. Thus, Factor 1 had substantial loadings on all 13 TA items - plus N10 - "Having someone watch you....", N30 - "Being given... numerical problems...on paper", and N24 - "...VAT at 15%". Factor 2 loaded on 12 of 13 NA items, except for N10. These results for the three-factor AFA suggested doing a two-factor analysis.

(c) The two-factor analysis

All six two-factor analyses produced results similar to the 3-factor AFA oblimin analysis, except that all three oblimin results here showed Factor 2 to load on only 10 of the 13 NA items, excluding the three "maverick" NA items, N10, N24, and N30; in these solutions, all of the variables loaded on one factor only. For the full factor-loading matrices for the two factor solutions, see Tables 6.35 (a), (b) and (c).

Summary: Because the four-factor analysis produced only three interpretable common factors, the analysis was redone with three factors.

The results of the three-factor analysis was as follows. For PFA and MLFA, the three factors found might be labelled as follows:
Factor 1: "academic maths evaluation anxiety" - including 5 of the original TA items, plus N10 and sometimes N24 and N30;
Factor 2: "maths course / class anxiety" - including the remaining 8 original TA items; and
Factor 3: "practical numerical anxiety, mostly money" - including 12 of 13 original NA items, except for N10.

For the three-factor AFA, and all the two-factor, analyses (especially with oblique rotation), the solution approached two factors, which might be labelled as follows:
Factor 1: "academic maths course / class / evaluation anxiety" - including all 13 original TA items, plus N10, N24 and N30; and
Factor 2 : "practical numerical anxiety" - 10 to 12 of the 13 NA items, except for N10 (and sometimes N24 and N30).

What is the meaning of the FA results for Rounds and Hendel's (1980) proposal for a two-dimensional sructure of mathematics anxiety - maths course / test anxiety and (practical) numerical anxiety? The three-factor PFA and MLFA solutions suggested fairly clearly 3 dimensions of maths anxiety. In these solutions, the maths course / test anxiety dimension of Rounds and Hendel was split into two factors - one to do with academic maths situations where evaluation is imminent or likely, and one associated more with the day-to-day activities of attending courses / classes in academic mathematics. For numerical anxiety, 10 of the 13 items associated with the planning or spending of money, or with "unspecified contexts" were associated with one factor. However, of the other items three items considered by Rounds and Hendel as "numerical anxiety", N10 ("being watched") was always classified with the maths evaluation items, and N24 (15% VAT) and N30 ("being given problems on paper") sometimes were.

The implications of the factor analyses for the ideas of "context" and context-specificity of anxiety in this study will be discussed in Sec. 6.4.

6.2 Modelling of Mathematics Anxiety Measures

In this and the next section, I investigate the remaining issues of the quantitative data analysis, to do with gender and social class differences in the outcome variables, and with the relationship between performance and maths anxiety. For this I use a different type of modelling - multiple regression. The outcome variables that will be studied in this way in this chapter are those pinpointed in the conceptual map (see Ch.4): namely, maths test and numerical anxiety (TA and NA) in this section, and school maths and practical maths performance (PERFS and PERFP) in the next.

6.2.1 Multiple regression modelling: aims and technical issues

Multiple regression (MR) analysis aims to explore the relationships of an outcome variable with a set of "predictor" or explanatory variables which are considered (normally for theoretical reasons) to influence (or at least to predict) the outcome variable. Like factor analysis, multiple regression is based on the pattern of correlations among the set of variables. However, unlike factor analysis, MR requires distinguishing between outcomes variables and predictor variables. (NOTE 3) It then allows the user to consider the "effect" on the outcome variable of changes in each predictor while all the others are simultaneously <u>held constant</u>. (NOTE 4)

MR models involve representing each outcome variable as a weighted sum of scores on the p predictor variables, as follows :

$$y = b_0 + \sum b_j \cdot x_j + e \qquad \text{over } j = 1,2,\ldots p$$

with y = outcome variable
with x_j = predictor variables
with b_j = regression weights (or coefficients)
with e = residual

One of the main measures of the "explanatory power" of a regression model is R-squared, or R^2, the proportion of variation in the outcome variable "explained" or accounted for by (its correlation with) the predictor variables. Other things being equal, the more predictor variables included in the model, the higher the value of R-squared. However, on the other hand, there is a limit on the number of predictor variables that can be included in any particular model for the following reasons. Suppose the predictor variables are entered in order of "predictive power" starting with the greatest. After a certain point, if the number of predictor variables were increased, the value of R-squared would tend to increase very little, and the estimates of the coefficients in the model would tend to become less precise, for two reasons - because of the loss of residual degrees of freedom (especially if the sample size is not large) and because the standard error of the estimates would tend to increase. This problem of imprecise estimates will be aggravated, if some of the predictor variables are highly correlated with each other (the problem of "multicollinearity"). For further discussion of regression modelling, see Draper and Smith (1980).

In this study, there were different numbers of students in each "cell" of the research design - for example different numbers of older "high qualified" males, older "high qualified" females, younger "high qualified" males, etc. (up to the 8 cells formed by the 2x2x2 breakdown). Therefore, a linear model was fitted for each of the outcome variables, using a procedure based on the classical analysis of variance (ANOVA) model with unequal numbers in the cells. (ANOVA and MR are both special cases of the general linear model.) Murray Aitkin has argued cogently for the use of hierarchical strategies in such situations (1977; 1979, pp.200-210). This involves building up an analysis of variance (ANOVA) model in <u>stages</u>, in order to decide on which predictor variables to include. The stages in the analysis were generally as follows:

1. Any explanatory variable considered for inclusion was tried in a 1-way ANOVA; it remained a candidate only if its effect was statistically significant, at approximately the 5% level. This is a stringent requirement.

2. The explanatory variables can be divided into those of "substantive" interest - gender, age, social class, qualification in maths, plus (in some models) maths anxiety and certain affective variables - and "nuisance variables" - year of entry and course; for the latter, what was of interest was not the size of the effect itself, but only controlling for it in the estimation stage. In the process of deciding on the basic set of predictor variables, a number of orderings of the substantive variables selected in 1. were tried, because of the possibility of drawing erroneous conclusions in the event that the main effects are highly correlated (Aitkin, 1977).

3. A series of models was then produced, each one based on the variables in the model produced by the preceding stage - plus one of the two-way interactions suggested as relevant, either by theoretical considerations or by the tables of observed means for the relevant subgroups (see e.g. sec. 5.5.1). Those interactions which were statistically significant in one of these models were entered into an

overall model, beginning with those involving the qualification in maths variable. (Because of the great emphasis in the literature on having taken courses in maths as an influence, especially on performance in maths, it seemed useful to control for interactions involving qualification in maths before allowing other interactions to be included.) Those interactions which remained significant in this new model were included in an overall model.

4. This overall model was checked "top-down", for example for 3-way interactions that were both statistically significant and theoretically interpretable, by running a full ANOVA model with all effects included. In this way, I decided on the set of predictor variables to be included.

5. Those of the predictors based on more than two categories (e.g. age classified as 18-20, 21-24, or 25+), and hence representing more than one "degree of freedom" (d.f.) needed to be re-represented for the MR model as two or more "dummy variables" (each with one d.f.). Then the contribution of each dummy variable for any overall effect, including interactions, was tested for inclusion separately, using the "stepwise" procedures.

6. Finally, regression coefficients were estimated, and estimates produced of the size of the "effect" for each independent variable, so as to allow the calculation of sex differences, say, with other factors controlled for.

6.2.2 Modelling of maths test anxiety and numerical anxiety

In these first analyses, the outcomes which were to be "explained", especially with respect to gender and social class effects, were expressed maths test anxiety (TA) and expressed numerical anxiety (NA). TA and NA were each based on the average of the responses to the 13 items designated by Rounds and Hendel as measuring "maths test anxiety" or "numerical anxiety" respectively (NOTE 5). It will be recalled that each of these items had invited a response on a 7-point scale, ranging from 1 = "very relaxed" to 7 = "very anxious", with the neutral point 4 = "neither relaxed nor anxious"; see APPENDIX Q1.

For reporting the analysis here, I decided to focus on the 1985 sample only, since it was the only one including social class variables. Besides gender and social class, the candidate predictor variables therefore included qualification in maths and age, as well as the student's course, one of two "nuisance" variables used only for purposes of control. (Year of entry was of course ineligible as a predictor for the 1985 sample, since a "variable" must vary.) Final versions of the models also tested for inclusion particular affective variables: for TA, difficulty with previous (school or college) maths courses (DFSM). and for NA, difficulty with using numbers (or "maths") in everyday life (DFED), and sometimes difficulty with numbers in work (DFWK) and use of numbers in work (USWK). Confident self-rating in school maths (CONFSR) and use of numbers in everyday life (USED) were omitted from the models of TA and NA respectively because the wording of the questions was in the present tense, rather than the past; hence these two variables, arguably had to be considered as <u>outcomes</u>, of the same sorts of factors and processes as would influence the maths anxiety measures. On this reasoning, it would not have been appropriate to use CONFSR or USED as <u>predictors</u> for NA and TA. This is an example of the importance of the requirement, referred to in the previous subsection, that the predictor variables should be "distinguishable" from outcome variables. For the wording of these questions, see APPENDIX Q7. For a summary of how all the outcome and predictor variables were scored and categorised, see the glossary in APPENDIX R3.

The results of using the procedures discussed in the previous subsection for modelling TA and NA for the 1985 sample are as shown in Table 6.4. (Where relevant, results from Table 6.4(a) for the whole sample (1983, 1984 and 1985 entrants) are cited for comparative purposes.)

For both maths test anxiety (TA) and numerical anxiety (NA), the predictors qualification in maths (QUAL), gender (SEX), plus both dummy variables for AGE, parental occupation (SCP - NOTE 6) and student's own previous occupation (SCS), were entered. Neither dummy variable for SAMPLE was selected by the stepwise regression procedures since neither was statistically significant at the 5% level. As for the affective variables, in the TA model, difficulty with previous maths courses (DFSM) was included; for the NA model, difficulty with using numbers in everyday life (DFED) and difficulty with using numbers in work (DFWK) were included, but not use of numbers in work situations (USWK).

The regression equations shown in Table 6.4 show that for TA, R-squared was 38.3%, and for NA, it was 30.1% (in both cases about 10% higher than the value for the model for the whole sample). However, these values were only 18.5% and 12.9% respectively before the "step" which selected for inclusion the affective variables (DFSM for TA, and DFED and DFWK for NA). Therefore there remained a great deal of variation in the maths anxiety variables - especially numerical anxiety - that was not accounted for by qualification in maths and the social variables of gender, age, and social class.

The estimates of <u>gender</u> differences were .49 and .09 of a scale point for TA and NA (both 7-point scales) respectively (These are reduced from the uncontrolled differences of .64 and .34 respectively for the 1985 sample; see Sec. 5.5.) This means that when qualification in maths, age, year of entry, course and the relevant affective variable were controlled for, women still <u>reported</u> 1/2 of a scale point higher on maths test anxiety than men - but only just 1/10 of a scale point higher on numerical anxiety. These differences, especially that for NA, were not large or "substantial" in terms of the underlying scale. Also, while that for TA was equivalent to about one-third of the standard deviation of TA for the 1985 sample, that for NA was equivalent only to one-tenth of a s.d. (see Table 5.1 (c)). And only the gender difference for TA remained statistically significant (at the 5% level). (NOTE 7) Alternatively, we could say that 95% confidence intervals for the gender differences would have been: .21 to .77 of a scale point for TA, but from -.17 to .35 of a scale point (i.e. including 0) for NA; these interval estimates are based on the same sampling theory as tests of significance, but they provide somewhat more informative conclusions. (NOTE 7a)

The gender differences may be compared to the estimates of differences due to qualification in maths: .40 of a response scale point for TA, and .24 for NA. This means that when gender, age, etc. were controlled for, students with A- or O-Level qualifications in maths reported about 2/5 of a scale point lower on maths test anxiety than those with CSE or no qualification, and about 1/4 of a scale point lower on numerical anxiety. Though this difference was statistically significant (5% level) for TA, that for NA was not quite on the borderline.

The social class differences observed without controls (see Sec. 5.6) were about .2 of a scale point for both TA and NA (with MC students reporting more anxiety than those with WC parents) , and about the same for those with previous non-manual jobs over those with manual work for NA and TA; the directions of both of these differences were unexpected. In these models, the estimates of social class differences, with qualification, gender, age, etc. controlled for, remained similar to the uncontrolled differences for parental occupation, at about one quarter of a scale point. For student's own occupation, however, the differences produced by the model, controlling for the other variables were now in the opposite direction - i.e. students with previous manual occupations were more anxious than those with NM jobs - but the differences were small and therefore negligible.

In estimating age differences, the discussion in Sec. 5.7 suggested it was necessary to keep three age categories (18-20, 21-24, 25+). The estimates of age differences were therefore set up as contrasts between each of the two older groups and the 18-20 year olds (the conventional H.E entrants). For both TA and NA, the age effects were negligible for the difference between the 21-24 and the 18-20 age groups, and small for the difference between the 25+ and the 18-20s (none statistically significant).

To summarise, for maths course / test anxiety (TA), the regression model continued to show the expected differences for gender and qualification in maths, after controlling for other variables. For NA, the two effects were smaller, and were not statistically significant in either case. Thus, both gender and maths qualification appear to make a difference to the "explanation" of differences in (expressed) maths test anxiety, but neither does so for numerical anxiety. The larger qualification effects for TA than for NA were to be expected, since success in school maths exams should diminish maths course / test anxiety more than it would numerical anxiety - assuming that the two dimensions were indeed measuring different "types" or situations of anxiety. Indeed, this result provides some support for the latter assumption.

For both TA and NA, the models produced estimates of parental occupation differences that were again in the unexpected direction (i.e. students with middle class parents reported higher levels of both dimensions of maths anxiety) but the differences were still not very substantial. The differences related to students' own previous occupation were negligible.

The most important conclusion is that there remained a great deal of variation in the maths anxiety variables that was not accounted for by qualification in maths, gender, age, and social class. Some - but only some - of this variation was accounted for when certain affective variables were brought into the models.

6.3 Modelling of Performance in School Maths and Practical

Maths

Issues (4) and (5) were concerned with whether there were gender differences, and social class differences in performance. Issue (6) was about the relationship between anxiety and performance. In this section, I address these issues through the modelling of the school maths performance score, PERFS, and the practical maths performance score, PERFP.

There were three series of regression models studied, aiming to elucidate the relationships of each of PERFS and PERFP with sets of predictor variables. For PERFS, the models were run on the whole sample without including social class, and also on the 1985 sample which included social class information. For PERFP, only the whole sample analysis, without including social class, was produced, for reasons given below. After a brief overview of the performance modelling process in sec. 6.3.1, the models for PERFS are discussed in sec. 6.3.2, and that for PERFP is discussed in sec. 6.3.3. The estimation of the maths anxiety effects and those for affective variables is considered in sec. 6.3.4.

6.3.1 Overview of the performance modelling process

The variables, predictors and outcomes, were measured and coded as they were for the modelling of mathematics anxiety; see APPENDIX R3. The six-stage modelling procedure used for performance also was basically the same as that described for the modelling of the maths anxiety variables in sec. 6.2.1 - except that all the models here included interaction terms.

Since the performance models were somewhat more complex than those used for maths anxiety, they were built up by using three (successively larger) sets of predictor variables, as follows:
(a) the basic model, with predictors qualification in maths, gender, age, social class (where appropriate), year and

course, plus appropriate interaction terms;
(b) the anxiety model with predictors as in (a), plus appropriate dimension(s) of maths anxiety; and
(c) the affect model with predictors as in (b), plus appropriate affective variables, chosen from confidence, usefulness, and difficulty.
In the reporting of the results below, it is normally the results of the most comprehensive model, the affect model, that is focussed on. However, results from the other models are discussed when relevant.

6.3.2 Modelling of school maths performance

Here I discuss the results of modelling school maths performance (PERFS), for the whole sample and for the 1985 sample (including social class measures). Table 6.5 presents, for both models, the predictor variables included, the the regression model produced, and the "effects" calculated for gender , social class (for 1985 only), and for the other predictor variables.

(a) the whole sample model for PERFS

The set of predictor variables included in the whole sample model for PERFS is shown in the left-hand column of Table 6.5. Besides QUAL (qualification in maths) (NOTE 9) and SEX (gender), AGE2 (age in 2 categories) was included, since it was found to produce a model with as good a fit as using AGE3 (age in 3 categories) for PERFS. Also included was YR1, a dummy variable for one of the two degrees of freedom for the YEAR variable, representing a contrast of the 1984 cohort vs. the rest (namely, 1983 and 1985); YR2 (1985 vs. the rest) did not reach the required level of statistical significance during the "stepwise" phase of the construction of this model, so it was not included. Similarly, one of the dummy variables for the student's course, SA1 (BASS vs. the DipHE courses) was included in the model, but not SA2 (BASS and QM vs. CM students, most of whom were not studying maths or QM during that year).

In this model, interaction terms were included for qualification by age (QxA2 or, in full, QUALxAGE2), sex by age (SxA2), and age by course (A2xSA1). The inclusion of these terms means that, for example, the value of the gender effects will vary depending on the student's age - and the value of the age effect will depend on the student's gender, qualification in maths, and course (since age interacts with each of these three latter variables). Finally, the maths anxiety and affective variables tested for inclusion were TA (maths test anxiety score), TASQ (its square), CONFSR (confident self-rating in school maths topics), and DFSM (difficulty experienced with previous maths courses). All but DFSM were selected.

For the PERFS model based on the whole sample, the proportion of the variation in PERFS scores accounted for by the full set of predictor variables, as measured by R-squared, was 29.1%. (It had been 21% for the basic model, and 25% for the model including maths anxiety but no affective variables.)

Let us consider the estimates of the sizes of the effects for differences in gender. Because the SEXxAGE2 interaction was included in the model, the estimates of gender effects depended on the student's age group, as follows:
0.16 of a question in favour of males for younger students (18-20);
0.57 of a question in favour of males for the mature age group (21+).
These estimates of gender effects were slightly lower than those produced for the basic model (no anxiety or affective predictor terms) - about one-third of a question (borderline statistical significance) for younger students, and three-quarters of a question for older students (21+).

What do these analyses mean? Let us consider in more detail the estimates of gender effects of 0.16 of a question for younger students, and 0.57 for mature students. First, the result of controlling for the other variables and terms in the model can be seen by comparing the size of these estimated differences with the observed gender differences - viz., 0.42 for 18-20s and 0.96 for 21+; see Sec. 5.5 (NOTE 10). That is, the effect of controlling for the other relevant factors via the MR modelling process was to reduce the size of the apparent gender differences by about two-thirds for the younger group, and by a bit under one-half for the mature students - basically because gender was correlated with qualification in maths and other factors which were also related to performance in the school maths subscale.

Looking at the size of the estimates of the effects in substantive terms will give us more insight into the meaning of the differences. The gender differences of about one-sixth of a question correct for younger students, and a bit over one-half of a question for mature students were not large in terms of the number of questions indicated, out of 10 in the PERFS subscale. Nor were they large relative to the standard deviation of the PERFS scores observed for the age subgroups for the sample as a whole: 1.23 questions correct for younger students in the whole sample, and about 1.8 for mature students (see APPENDIX R8).

We may allow for possible sampling error by testing the statistical significance of these effects, or by producing confidence intervals for the estimates. (NOTE 7a) For example, a 95% confidence interval for the value of the gender differences for younger (18-20) students is between -0.42, i.e. half a question in favour of males, and +0.10 of a question, in favour of females. (NOTE 11) This means that, if we were to take samples repeatedly in the same way as the sample was produced here - assuming that the samples could be considered as being approximately random (see sec. 4.3.3) - we would find that the estimate for this gender difference would range between 0.10 and -0.42 in 95% of the sampling occasions.

If we wished to test the statistical significance of this difference, we could note that the confidence interval already produced includes 0.0 and hence we cannot reject the idea that the gender difference for younger students is zero (the null-hypothesis). Alternatively, if we did a significance test of the gender difference, we would find it not to be statistically significant (p >> .05).

The estimate of the gender difference for older (21+) students was -0.57; its standard error was calculated as 0.13 (NOTE 11). In this case, the confidence interval was -0.31 to -0.83 (NOTE 7a), i.e. between one-third and five-sixths of a question in favour of males. When tested, the size of this difference was found to be statistically significant (p<.001).

Similar analyses could be carried out for the estimates of other differences, using the results in Table 6.5.

(b) the 1985 model for PERFS, including social class

The analyses concerned with social class used only the three 1985 subsamples (since there were no social class questions in 1983 or 1984); for the results, see Table 6.5. Here, I shall concentrate on comparisons of the 1985 model with the whole sample model for PERFS discussed in subsection (a).

First, the set of predictor variables was as shown in the right-hand column of Table 6.5 above. In addition to the main effects included in the previous model, parental occupation (SCP) and student's own occupation (SCS) were entered. (The social class variables were only sometimes significant when entered first in PERFS runs, but it was decided to force both SCP and SCS to enter the model, so as to be able to estimate the social class effects.) A number of two-way interactions were also entered into the model. The QUALxSEX interaction was found to be significant at the 5% level for this model (NOTE 12), as well as the QUALxAGE2 and the SEXxAGE2 interactions. The interaction of SEX with SCP was not significant at the 5% level, despite indications in the literature that social class differences in school maths performance were greater for girls than for boys in some US studies, and despite the apparent confirmation of such (uncontrolled) differences for PERFS in Table 5.9. (NOTE 12a)

The gender effects depended on the student's qualification and age group, because of the QUALxSEX and SEXxAGE2 interactions, and were estimated as :
0.50 of a question in favour of _females_ for the younger (18-20) high-qualified group;
0.34 of a question in favour of males for the mature high-qualified;
0.62 of a question in favour of males for the younger low-qualified;
1.46 questions in favour of males for the mature low-qualified.
Only the latter difference was statistically significant. (The related 95% confidence interval was 0.76 to 2.16 questions correct.) However, for the first time, there emerged an estimate for a gender difference in favour of _women_, amongst the high-qualified younger group. Though this difference was not quite statistically significant (.5 of a question, with standard error of .30 of a question), it was interesting - especially in a milieu where amongst the highly qualified younger students, we might have expected a difference in the opposite direction.

We could compare these results with those from the whole sample model for PERFS, by averaging the gender effects over high and low qualification in maths, to find the following :
0.20 of a question in favour of _females_ for the younger group;
0.97 of a question in favour of males for the mature group.
That is, in the 1985 sample, the estimated gender difference in PERFS was in favour of women for the younger group (school-leavers) - but it was small and only suggestive (i.e. not statistically significant). This was not in effect different from the whole-sample estimate, a gender difference of about one-sixth of a question in favour of _men_

- again only suggestive. The gender effect among the mature students was substantial - almost a whole question - and somewhat more than that found in the whole sample (just over half of a question).

For qualification in maths, because of the QUALxSEX and the QUALxAGE2 interactions, the effects depended on the student's gender and age group; the estimates are shown in Table 6.5. (NOTE 13a) The most striking result was the very high estimated difference due to maths qualifications for older women: at about one and one-half questions, it was the only difference which was statistically significant (with a 95% confidence interval of 0.86 to 2.1 questions correct).

Age differences depended both on the students' gender, and on their level of qualifications in Maths, because of the interaction terms involving AGE2. Here the most striking result was the estimated difference for low-qualified women - almost one and a quarter questions in favour of younger students; this was the only statistically significant difference, and compared with an estimate of 3/4 question for this same group in the whole sample model (obtained by averaging over course groups). Again we see that the different model, based on a subsample, produces estimates different from those for the whole sample.

To summarise, there appears to have been a group of students who, after controlling for other variables in the model for the 1985 sample, consistently performed lower than any other - namely the mature female group who were "low-qualified" in maths. This group has already been identified by the analysis of partly controlled results on the basis of a gender / age / qualification breakdown in Ch.5; see Fig. 5.3(a) which presents results for the whole sample. (NOTE 14)

For social class effects, I first consider the hypothesis that students with middle-class parents should perform better in PERFS than those with working-class parents. The estimate for MC as compared with WC parents, controlling for other variables, was 0.28 of a question (standard error = .21). (This estimate can be compared with the uncontrolled difference reported in Table 5.8, i.e. 0.22 of a question.) This gives support to the hypothesis - but only weak support, since the estimate of parental background effects is not statistically significant.

Next I consider effects of the student's own occupation. The main effect for NM work experience as opposed to Manual work was -0.15 of a question, i.e. only about one-sixth of a question, in favour of those with previous manual occupations. Again, because the confidence interval includes zero, we cannot be sure that the estimated value was non-zero. This estimate could be compared with that calculated from the observed means in Table 5.10, i.e. 0.40 of a question, in favour of those with previous manual occupations. Thus, controlling for sex, age, qualification in maths, parental social class, and other variables, using the regression model led to a reduction in the size of the anomalous difference related to student's own previous occupation.

Overall, the results from the two models for PERFS, school maths performance, are mutually supportive. The difference in the values of particular regression coefficients, and in the associated estimates (of, say, gender differences) between the whole sample analysis and the 1985 analysis could be explained partly by the difference in samples - and also of course partly by the selection of slightly different sets of predictor variables for the two models. For the 1985 model, R-squared (the measure of goodness-of-fit) was 39.7% - about 10% more than the value for the model for PERFS based on the whole sample. (NOTE 13)

The maths test anxiety effects for PERFS will be discussed in detail in sec. 6.3.4. But first, I discuss the parallel process of modelling practical maths performance, PERFP.

6.3.3 Modelling of practical maths performance

The model for practical maths performance, PERFP, was produced using the same procedures as those for PERFS. Table 6.6 presents the predictor variables included, the final regression model for PERFP, and the estimated effects. The set of predictor variables included QUAL, SEX, and AGE3, age in 3 categories, the age variable that was found to be necessary for studying age differences in PERFP (see APPENDIX R8). I chose the following two dummy variables to represent AGE3: AGE2 (mature students (21+) contrasted with the younger 18-20 group), as used in the analyses of PERFS above; and AGEQ (18-20s and "older" 25+ groups contrasted with the "intermediate" 21-24 year olds), a sort of "quadratic" effect. These were suggested as appropriate by the pattern of observed differences in PERFP (see APPENDIX R8).

Neither parental occupation (SCP) nor student's own occupation (SCS) was statistically significant at the initial testing stage, and hence neither was included. Of the relevant affective variables, both the numerical anxiety (NA) score and its square (NASQ) were included, as well as the measure of difficulty in using numbers in everyday life (DFED). (NOTE 15)

The value of R-squared for this final PERFP model for the whole sample was 16.9%. (It had been 11% for the basic model, and had increased to 15% for the model including the maths anxiety variables, but without the affective variable DFED.) This can be seen to be some 12% less than the value of R-squared for the PERFS model for the whole sample discussed in sec. 6.3.2. Though the PERFP model included one fewer predictor term, this large difference nevertheless indicates that the modelling accounted for notably less of the variation in PERFP than it did for PERFS: there remained more of the variation in PERFP which was "unexplained" by the model.

The estimate of the <u>gender</u> effect was 0.27 in favour of males, about one-quarter of a question. (There were no interaction effects with QUAL or with AGE in this model.) This can be compared with the uncontrolled difference of 0.57 of a question in favour of males (see Sec. 5.5). Thus, a reduction of the order of one-half was due to the controlling of other variables, and was of about the same order as the reduction in gender effects as a result of the PERFS modelling. From the value of the standard error of the estimate given in Table 6.6, the 95% confidence interval for the gender effect can be calculated as being between 0.01 and 0.53 of a question; thus the estimate of the effect was statistically significant just at the borderline 5% level. But one-quarter of a question is not a very substantial difference.

The effect of having a ("high") qualification in maths was estimated as 0.69, about 2/3 of a question, or about one-third of a standard deviation (1.94 questions for PERFP overall); it was clearly statistically significant. But the size of the qualification effect is perhaps surprisingly high for an outcome measure, PERFP, that is meant to relate to numeracy in practical contexts.

For the age effect, the estimates depended on the student's course - BASS or the Dip.HE - because of the AGE2xSA1 and AGEQxSA1 interactions; see the array of age estimates in Table 6.6. If we were to produce equally-weighted averages of these estimates over the courses, we would get the following estimates of differences:

0.37 of a question in favour of 18-20s relative to 21-24s;

0.08 of a question in favour of 18-20s relative to 25+s.

(It is worth noting, however, that the first estimate resulted from averaging two estimates that were very close together, whereas the second resulted from two very different estimates.)

Thus the overall estimated difference between 18-20s and 25+ entrants was almost zero and the estimated superiority on PERFP of the 18-20s (and hence necessarily the 25+) over the 21-24s, was relatively large (one-third of a question), though this was not substantial. Taken together, these suggest that there was a sort of quadratic effect for age with respect to PERFP, with the 18-20 and the 25+ groups approximately equal, and the 21-24s disadvantaged, in comparison with both groups.

The latter pattern might suggest, always assuming that the PERFP questions were valid indicators for "practical maths" performance, that the 25+ students had particular background and experience which allowed them to perform better than the 21-24 year group in this context. However, when possibly relevant controlling variables - such as work experience, or use of numbers in work (USWK) or in everyday life (USED) - were examined in APPENDIX R8, no differences that might have explained the quadratic variation of PERFP with age group were found. This suggested areas that might be pursued in the interviews.

6.3.4 Affect, anxiety and performance

Issue (6) related to theoretical expectations that maths test anxiety should relate to school maths performance, and that numerical anxiety should be a predictor for practical maths performance. It was also of considerable interest to assess whether the relationship between maths anxiety and performance in each case was simply debilitating (i.e. linear and negative), or whether there an optimal level of maths anxiety - indicated by an "inverted U" (i.e. quadratic) relationship; see sec. 4.1.3 (h).

For PERFS (school maths performance), maths course / test anxiety (TA), and its square (TASQ) were included both for the whole-sample model, and for the model including social class variables (1985 sample only); see Table 6.5. For PERFP (practical maths performance), numerical anxiety (NA) and its square (NASQ) were entered; see Table 6.6. In the regression equations, the coefficients for the quadratic term, TASQ or NASQ, were statistically significant beyond the 5% level in each case. Thus the model provided strong support for an inverted U model in all three cases.

If we isolate out the relevant parts of each of the three equations, we have:

PERFS = 5.64 + ... + .43 TA - .06 TASQ (whole sample)
PERFS = 5.92 + ... + .77 TA - .11 TASQ (1985 sample)

PERFP = 7.98 + ... + .47 NA - .12 NASQ (whole sample)

Very approximately, by using the usual procedures for finding the extreme values for a function, we could interpret each of these equations to represent a quadratic relationship which reaches a maximum (or "peak") at a value of TA = 3.6 (or 3.5) in the case of PERFS. In the case of PERFP, the relationship reaches a peak at a value of just about NA = 2. Given that the anxiety items required responses of between 1 and 7 on a "symmetrical" scale (see the questionnaires in APPENDIX Q1), TA = 3.6 would represent an average response (to the 13 maths test anxiety items) slightly closer to "neither relaxed nor anxious" than to "fairly relaxed"; NA = 2 would represent an average response to the 13 numerical anxiety items of "relaxed".

Thus, the "peak" or maximum value estimated for the relationship between PERFS and TA was located at a point close to the theoretically "reasonable" neutral point (4 = "neither relaxed nor anxious"), above which respondents were reporting themselves "anxious" and below which they reported themselves to be "relaxed". This provided additional support for the idea of a quadratic relationship between PERFS, school maths performance, and TA, maths test anxiety. The evidence for a quadratic relationship was less substantial in the case of PERFP, since the peak was not estimated at or near the neutral point. However, since the NASQ term in the model was statistically significant, an inverted U relationship was still confirmed.

In each of the models, one or two affective variables, besides the maths anxiety variables, were tested for inclusion. For the PERFS models, confidence (CONFSR) was included, and difficulties in maths courses (DFSM) was not. For the PERFP model, difficulty with numbers in everyday life (DFED) was included; no others were tested. The coefficients for confidence in the two PERFS models were substantial - two-thirds to three-quarters of a question. (The 95% confidence intervals were .54 to .94, and .21 to 1.01 of a question, respectively.) The coefficient in the PERFP model for difficulty with using numbers in everyday life (DFED) was less substantial, at about one-third (0.31) of a question, but it was also statistically significant.

Thus, the affective variables made a contribution in addition to that made by the maths anxiety variables, and this modelling exercise shows the importance of including both maths anxiety <u>and</u> other affective predictors.

6.4 <u>Summary</u>

The modelling described in this chapter aimed to continue and enhance the discussion of five of the six major issues highlighted in Chs. 4 and 5 for the data analysis of the questionnaire.

Concerning issue (3), the context of expressed mathematics anxiety as studied here, the factor analyses largely confirmed the basic differentiation by Rounds and Hendel (1980) of the items from the MARS scale into "maths course / test anxiety" and "numerical anxiety" dimensions - with several important elaborations. First, though some of the solutions produced two dimensions very similar to Rounds and Hendel's two, others produced three dimensions - by splitting "maths course / test anxiety" into one dimension related to evaluation in academic mathematics situations, and one related to attending maths courses and classes, with the "numerical anxiety" dimension <u>almost</u> unchanged. However, in all of my solutions, one (or, in some solutions, two) items classed by Rounds and Hendel as "numerical anxiety, context unspecified", but describing a calculation which was "given" or "watched" by another, were grouped with the maths evaluation items - as was (sometimes) one item classed as "numerical anxiety, money", but describing a percentage calculation more often done in school than outside.

Thus the factor analyses have several interesting implications for the discussion of "context" in this study. First, for this particular sample of social science undergraduates, many of them mature students - or indeed for any sample of people at all - they raise the question as to whether any item could be considered to have its context "unspecified". (NOTE 16) In particular, for the two such numerical anxiety items mentioned above, the results of the factor analyses suggested that the subjects may have placed them in a definite context - in the sense of responding to them in the same way as for academic mathematics situations (perhaps with evaluative overtones). Second, for at least one item, an action or task that first appeared to form part of some "practical maths" activity might be more accurately described as part of "applied school maths"; e.g the item "Figuring out VAT at 15% ...." (NOTE 16a) Finally, the importance of a feeling of being evaluated in academic mathematics contexts was indicated by the dominance within one of the factors of items evoking such a feeling.

Issues (4) and (5) were concerned with the size of gender and social class effects, for maths course / test anxiety and for numerical anxiety as outcomes (with the compositions of items as proposed by Rounds and Hendel and other researchers); here multiple regression models were used. For TA, both models continued to show the expected difference for gender, even after controlling for the other relevant variables. However, for NA, the gender effect was smaller, and not statistically significant for the main model used (1985 sample, though it was borderline only for the larger whole sample analysis. The larger gender difference estimated for TA than for NA raises the question as to whether school mathematics has been a context where there may have been clearer gender differentiation - in terms of maths anxiety at least - than there has been in everyday practical contexts.

For both TA and NA, the results for social class were less clear. For parental occupation, the modelling suggested, as had the uncontrolled results, that students with middle class parents reported higher levels of both dimensions of maths anxiety - but the differences were not large. For student's own previous occupation, the differences were too small and unstable to support any dependable conclusion.

Certain affective variables were brought into the models. For maths test anxiety, difficulty with previous maths courses (DFSM) was included; for numerical anxiety, difficulty with using numbers in everday life (DFED) was included, and difficulty with using numbers in work (DFWK) (for the 1985 model only). This suggests that the level of (academic) maths test anxiety reported by students might be related to the degree to which they had experienced "difficulty" in previous maths courses, and the level of practical numerical anxiety might be related to the degree of difficulty in everyday or work situations. This suggested areas that might be explored in the interview phase of the study (see Chs. 9-11). In addition, however, there remained a great deal of variation in the maths anxiety variables that was not accounted for by the modelling.

Another issue of interest in this chapter was the reconsideration of the uncontrolled gender and social class differences in performance discussed in Ch.5, with controls for qualification in maths, age, and appropriate interaction terms, etc. Multiple regression was therefore also used here to produce models for school maths performance and practical maths performance. In the case of gender, most of the uncontrolled differences were reduced by at least one-half. For PERFS, the gender difference in favour of men continued to hold only for mature students for the whole sample; the more specific analysis for the 1985 sample suggested that the gender differences in favour of men were mainly located among low-qualified mature students. For PERFP, the gender difference in favour of men was no longer substantial (1/4 question), and was only of borderline statistical significance. Thus, the gender differences reported here are by no means as clear-cut as those reported elsewhere, for example in the studies of students of school age, or in the studies of adults done since the early 1980s (see Ch. 2).

The 1985 analysis of PERFS allowed estimates of gender, qualification and age effects which were somewhat more context-specific (in that the model included more of the relevant interaction terms) than did that for the whole sample: the results reported above seem to suggest that there was a group of students with especially high performance deficits, who tended to be mature (21+), lacking in O- or A-level maths, and female. This finding is relevant in two areas: for research projects like this one, it provides a basis for the selection of students for interviewing; and for course provision in tertiary institutions, it points in fairly specific terms to the sort of group that might have particular needs.

The 1985 sample also allowed the estimation of social class differences, but initial testing indicated this to be worthwhile only in the model for PERFS. The estimate of the parental occupation (SCP) difference was in the expected direction (middle-class higher than working-class), and was slightly larger than the uncontrolled difference, but was still not substantial (one-quarter of a question). This finding was somewhat surprising. Of course, the measure for parental occupation (and for the student's own occupation) were based on the Registrar General's occupational classification, and therefore might not have provided a valid measure for relevant differences in parental perspectives on education. Further, if we consider the wording of the relevant question, we find that respondents were asked for their father's and their mother's "paid work when you began secondary school": this would have involved recall, certainly going back at least seven years for the younger students and considerably longer for older ones. Both of these issues may help to explain the failure to observe the expected result.

No difference based on the student's own most recent occupation (SCS) ("non-manual" vs. "manual") had been expected for SM performance, and the results confirmed this. On the other hand, SCS differences had been expected for practical maths performance (PERFP), on the basis that NM work would provide familiarity with numerate thinking - but this was not found. One explanation might relate to the validity of the indicator for SCS: this puzzle and the unstable findings for the maths anxiety variables related to SCS have raised basic questions about it. (NOTE 17) Or there may be problems with the measure for "practical maths performance". Or the relationship as conceived so far may be too general: advantages for specific types of numerate thinking may come from familiarity with specific work practices (see the Interlude below).

Another issue of interest was whether the relationship between maths anxiety and performance is simply debilitating, or whether maths anxiety is sometimes facilitating. A striking result of the use of the controls provided by regression modelling was the confirmation of a quadratic relationship between school maths performance (PERFS) and maths course / test anxiety (TA), on the one hand, and that between practical maths performance (PERFP) and numerical anxiety (NA), on the other. That is, each "type" or context of performance was related to the relevant type of maths anxiety, and the shape of the relationship found in each case was reminiscent of the "inverted U" of the "Yerkes - Dodson Law" (see Ch.3). This finding provides a challenge for recent theories of maths anxiety, which have tended to see anxiety as having a purely debilitating effect on performance. (NOTE 18) Further attempts at replicating these findings are needed.

Besides the effects due to the two maths anxiety dimensions, there were substantial differences (i.e. greater than half a question) estimated for the effects of confidence for both of the models for school maths performance. The fact that these differences were produced while the effects of maths course / test anxiety (TA) were controlled for suggests that maths anxiety and confidence (at least as measured here) might have had effects on SM performance that were to some extent independent. That is, contrary to suggestions in earlier research (e.g. Fennema and Sherman, 1976), it may not be appropriate to conceive of confidence and anxiety - despite a high intercorrelation - as "opposites", or as in some way "reducible" to one another. This again shows the usefulness of the statistical modelling.

The final issue which may be illuminated by the modelling is (2), the question of whether the differences between performance in the school maths context and numerate performance in practical contexts are satisfactorily captured by the difference in the "school maths" and the "practical maths" subscales. Some support for the idea that these two subscales are "measuring different things" is given by the differences in the models produced: one can note the differences in predictor variables included, and the differences in coefficients for each predictor in the equation for PERFS (for the whole sample) in Table 6.5 and that for PERFP in Table 6.6. However, this support is limited: these differences in themselves are certainly not sufficient to conclude that the two subscales capture the full richness of differences in performance in different contexts.

In general terms, the use of modelling has allowed the context-specificity of particular effects to be considered in two distinctive ways. First the inclusion of interaction terms allowed us to distinguish those subgroups of the population within which particular differences were substantial - or not. Second, the inclusion of contextual variables allowed us to study how effects varied across settings; here the course and the year of entry played this role.

All these conclusions point to a further, methodological, conclusion. The use of regression modelling as a way of reconsidering previously uncontrolled differences and relationships has been valuable in several ways. First, some previously substantial uncontrolled differences, such as those for gender, were reduced by about one-half, and some were no longer considered to be as clear-cut as much previous research had suggested. Second, what appeared to be simply debilitating relationships between maths anxiety and performance when they were uncontrolled, could be seen as involving an inverted U type of relationship when the relevant controls were included; yet it has been this first "appearance" which has been accepted in most recent research in the field. In both cases, what may be theoretically limiting ideas have continued to be accepted in some quarters because of limitations in the methodology used to research them.

INTERLUDE

REFLECTIONS ON THE CONCEPTUALISATIONS AND THE RESULTS SO FAR

We have now reached the end of the reporting on the first part of this study, based on the questionnaire which aimed to investigate adult students' experiences with maths, their performance in maths, and their feelings about mathematics, especially maths anxiety. The results and analyses in the last two chapters have challenged a number of ideas which were previously somewhat uncritically accepted: that men perform better than women at maths; that women have more maths anxiety than men; that maths anxiety is simply debilitating in its effects on performance. These analyses have also helped to provide additional insights about the relationships considered to hold among the variables of interest; for example, they point to a subgroup of this sample (older, female, with "low" maths qualifications) scoring particularly low on performance and high on maths anxiety, as measured here.

However, there remain a number of basic questions about the conceptual basis of the research so far. For example, if we consider one of the findings of interest, the inverted U relationship between the school maths performance score and that for the maths test anxiety subscale of the MARS, it is pertinent to ask - what does this mean ? The finding can be interpreted as follows: in a particular setting, on average across a particular sample, a score taken to indicate performance in a particular set of items on a particular occasion was associated with a score indicating (expressed, "trait") anxiety to do with maths courses and assessment, and with other affective variables (confidence) - while controlling for qualification in maths, social variables (gender, age, social class), etc. Now, if we here leave aside the issues of sampling (see Ch.4) and controls (see Ch.6), this allows us to focus on issues to do with: (i) the context; (ii) conceptualisation and measurement of performance; (iii) conceptualisation and measurement of anxiety; (iv) the type of relationship assumed; and (v) the general (averaged) quality of the results.

Basically, as has been indicated, in the quantitative part of the study so far, the context was meant to be specified by the wording of the particular item for performance or for anxiety. Thus, the findings were based on two crucial divisions - in each case, between two different contexts (or sets of contexts). The first was the division of the performance items into school maths (SM) and practical maths (PM) types: SM questions were abstract, whereas it was intended to locate PM questions in some practical context, by referring to a particular situation in the wording of the problem. The second was the division (from previous research) of mathematics anxiety items into ("academic") maths test anxiety and ("practical") numerical anxiety dimensions. The correlations between overall scores for the two dimensions of the maths anxiety, and the related factor analyses, gave strong, though not unqualified, support to the division between maths test anxiety and numerical anxiety, as measuring anxiety in different contexts. However, the results for performance (correlation between subscales, comparisons of models) are considered to give much less strong support to the idea that the school maths and the practical maths performance subscales were measuring different "types", or different contexts, of performance.

For performance, not only were the results not encouraging, but it was difficult actually to make the distinction between abstract / academic and practical performance for particular items. Thus, with the possible exception of Qu. 14 on inflation (and Qus. 22 and 23 on opinion polls), most of the "practical maths" questions, on closer scrutiny, could be seen as what are sometimes called "word problems". Both these and the "abstract" questions might well be found in many school contexts. In particular, Qu. 17 (averaging ages of a group of students) referred to an action that would not clearly form part of very many (if any) "practical" activities for a student; even Qus. 19 and 20 (reading a graph of temperature changes) related to practical activity that might not be recognisable as such to very many of the student respondents in this survey. These questions were examples of what might therefore be called "applied school maths" items: they appear to be practical, but on closer scrutiny are more likely to be a vehicle for using skills and ideas that arise as part of school maths - and they are generally perceived by students as such. This raises the question as to whether the PM performance items really were practical, and therefore whether the SM and the PM items really were grounded in different contexts. The problem of context was further complicated for the performance measures at least, because the survey was completed in a setting that for many students was probably reminiscent of testing or exam situations at school or college. Thus, rather than being certain that the different items in the performance scale provided variation in contexts of performance, we might have to allow that they may have varied in background or wording only.

The problem may not have been so great for the anxiety items. However, it will be recalled that some pilot testers averred that they could not respond properly to some of these items, because the context was not sufficiently specified (see sec. 4.3.1). This at least raises the general question as to whether the SAS items specified a context with sufficient detail and credibility. Further, with respect to the division between maths test anxiety and numerical anxiety, some researchers have attempted to "re-create" the separate contexts, by depending largely on factor analysis. This is somewhat mechanical, if it is the only way of investigating the meaning of the different contexts for respondents.

Therefore, on reflection, I considered that the context in which a person thinks about a mathematical problem needed a much fuller description, and that further study was needed on how cognition, performance and affect depend on the context. I shall reconsider these issues, in the second part of the thesis.

There were closely related questions, to do with the conceptualisation and measurement of the main outcome variables. "Performance" has so far been measured as counts of items "correct"; qualitative information on type of "strategy" used and on the subject's perception of the relevant context have been lacking (NOTE 1). Maths anxiety, and affect generally, so far have been seen basically as personal "traits", which are observable, and on which one can be assigned a quantitative score. Maths anxiety has been measured indirectly by self-reports of responses to situations described briefly in a questionnaire item. Though convenient to use, these methods may have limited validity and reliability. For one thing, an individual's response to his or her reading of a self-report item on a anxiety scale may differ from their response in an actual situation similar to that described in words. Therefore, in the next part, I attempt to assess performance and anxiety in a situation where subjects can respond to a series of different problems over the course of an interview - and can report on, and evince, their responses to talk about maths and numbers, and to actually attempting problems involving them. I aim to consider qualitative aspects of performance (e.g. strategies) and qualitative differences in affect (e.g. attempting to differentiate anger from anxiety), as well as quantitative aspects. I shall attempt to "triangulate" several methods of measuring anxiety by observing overt behaviour, and by using methods informed by psychoanalytical perspectives.

Aiming to gauge the value of these latter methods is appropriate because the analysis so far has not taken on board Freud's insight that anxiety may not be observable in any simple way, precisely because of defence mechanisms which operate to occlude, or to modify, its expression (see Ch.3). In the next part of the study, I attempt to consider the implications of these ideas for the study of maths anxiety and affect more generally.

Next, I must consider the type of relationship assumed between maths anxiety and performance, and - if it is considered to be causal - the direction of the effects. Certainly, the early formulations of the "Yerkes - Dodson law" were meant to be causal (with anxiety affecting performance), since it was developed within a stimulus - response framework, and in many of the early studies, the level of anxiety or "stressor" was allocated experimentally (Levitt, 1968). However, the move of the focus, from experimental studies and relatively transitory ("state") anxiety to surveys and relatively fixed ("trait") anxiety, raises issues whose full implications became clear to me only later in this work. Once anxiety is seen as "trait", problems arise with the time ordering of the relationship with performance, especially when the performance measure is seen as "characteristic". (NOTE 2) These problems would have been heightened in my study by the ordering of the maths anxiety items <u>after</u> the performance items, so that the experience with the performance items was likely to affect responses to the anxiety scales. This would imply the possibility of causality in both directions, and would vitiate the use of the sorts of regression models used in Ch.6. (NOTE 3) This discussion emphasises the need to be cautious concerning claims about causality and its direction in statistical work such as that reported here.

Finally, the differences and relationships reported have been general, in the sense of being based on <u>averages</u> across subjects (in subgroups); this implies that certain specific processes or meanings in the development of mathematical thinking or affect in a particular subject may have been occluded by the generality of the analysis. The problem may have been attenuated by the use of statistical models (which allow for particularity, e.g. in subgroups, but only to some extent) - but it has certainly not been solved. With respect to the attempt to account for differences in performance scores and in maths anxiety, the regression models were not particularly powerful, even in their own terms, since the values of R-squared tended to be low (no more than 30% for models based on the whole sample, and somewhat higher for those based on the 1985 cohort). That is, variation in the performance and maths anxiety variables was not well "explained" by these models. This suggests that the unexplained variation was more specific than social structural factors could account for in these models - or perhaps even that it was individually determined. Thus, the subsequent analysis will attempt to examine the differences, as well as the similarities, in the way that particular subjects with apparently similar "structural characteristics" (e.g. gender or social class), have been positioned in school mathematics, or other practices. This will involve the use of ethnographic approaches, and analysis of the "discourses" drawn on by subjects, in the second part of the study.

But first I reconsider the idea of cognition in context in Chapter 7.

CHAPTER 7 : NUMERACY AND CONTEXT

- Why are waiters especially good at arithmetic?
- Because they know their tables!

(Joke in Christmas Cracker, 1990)

- Keith, if I had eight apples in my right hand and ten apples in my left hand, what would I have?
- Huge hands, Sir!

(Joke in Christmas Cracker, 1991)

In this Chapter, I develop the idea of numeracy-in-context, or numeracy as specific to practices - earlier called N2 (see Sec.2.4) - by considering further what might be meant by the "context" of numerical thinking. I begin by considering how the idea of context has been used in mathematics education and psychology - in Cockcroft's and post-Cockcroft approaches (Sec.7.1), in ethnomathematics (Sec.7.2), and by the Brazilian school of Carraher, Carraher and Schliemann (Sec.7.3); all of these approaches seem to offer an approach based on a functional numeracy (N1) view - or one not too dissimilar. I then consider two clusters of theories that seem to offer a more promising way of thinking about numeracy as N2 - as activity-in-context, or as cognition-in-practice. I discuss the work of American psychologists such as Sylvia Scribner, Michael Cole, Jean Lave and others, under the broad heading of "activity theories" (Sec. 7.4), and that Valerie Walkerdine and other "post-structuralists" (Sec.7.5) - particularly the idea of a "discursive practice" which represents a well-developed attempt to talk systematically about context.

The work of all these researchers will be examined to draw out their ideas of context. I also consider the various researchers' ideas about the possibilities of the "transfer" of learning from one context to another.

7.1 Utilitarian Views

Research into the use of mathematics in practical work and everyday contexts has sometimes been termed "utilitarian" (e.g. Dowling, 1991). It has been based usually on the ideas of functional numeracy (N1) (or, perhaps, on basic skills numeracy (N0)). In these approaches, the context is assumed to be defined naturally, basically by naming it as, say, "clerical work" or "school geography"; see the discussions of the APU's work based on N1 (and of Rees and Barr's based on N0) in sec. 2.1.3.

The Cockcroft Report (1982) provided a strong basis for utilitarian views. The approach of those researching for Cockcroft to specifying the context of interest was to attempt to analyse the activities involved - e.g. "everyday life" - for the numerical skills needed by adults in order to cope within it. There appear to be basically two ways of doing this:

- interviewing the adults (or where appropriate their employers); or
- observing them involved in the activity in the appropriate setting. (NOTE 1)

Most of the work discussed in this section used some version of interviews (or questionnaires); observation in situ was used for many of the studies discussed from Sec. 7.3 onwards.

Brigid Sewell's study (1981) is one of the few done of the numerate skills needed by adults in everyday, non-work, situations. She decided to interview members of her sample twice. The first time was to "ease tension", and to discuss situations in which maths might be used - the "mathematical needs of daily life" (p.1) - and the respondent's attitude to mathematics. The second interview was to discuss in detail strategies for solving, and actual answers for, problems chosen for their common relevance. (NOTE 2)

The questions in the main part of the first interview mostly specified an activity selected from a list of "commonly-encountered situations in which some mathematics might be used" (1981, p.8) compiled by Sewell herself - and then asked whether the respondent (habitually) did each; for example:

- whether they checked their change when shopping for one or two items: 79% said yes; and
- whether they measured material for decorating at home: 91% said yes.

A notable finding was the wide variety of methods used by individuals, for example in response to the question on how they knew they had enough money to pay for the items in their trolley at the supermarket (p.13). This was seen by Sewell's sponsors as "contradicting the view that there is a 'best' method in real life, even if there seems to be only one in school lessons" (ACACE, 1982, p.33). There was no apparent correlation between the extent to which an individual used maths, and the length of their initial education, or their social (occupational) class.

In addition, the first interview produced some indicators of affect in two ways. First, the refusal rate for the first interview was about one-half (1981, p.11) and Sewell attributed this to potential respondents' perceptions of maths as a "daunting subject" (p.11). Second, in answer to Question 22: "Do you enjoy working with numbers?", half the sample said yes and the other said no "with varying degrees of antipathy"; in answer to Question 23: "How well would you say you can manage in everyday situations when numbers are involved?" 76% answered "very well" or "all right", 18% "mostly" and 5% "with difficulty". (NOTE 3) The unsolicited remarks about the experience of maths were much more negative (p.16).

The aims of the second interview were: to offer a number of "mathematical" questions about a range of situations, where she expected the interviewees to "behave as they normally would in those situations, whether by performing a calculation or adopting some evasive strategy"; also to give respondents the opportunity to say anything they wanted about their school experience (p.20, my emphasis). Further,

> Original documents (bills, payslips, timetables) were used to make the questions as realistic as possible. [...] Mathematically, the content of the second interviews was formulated as near as possible to the realities of everyday life ... (including) the 4 rules, percentages, averages, and ratios; within these there were whole numbers, decimals and fractions, metric and imperial units. More importantly, the questions were posed not as number sums on the page, but within a real context. Nor were the numbers simplified - they actually had occurred and were mostly 'awkward' because of that.
>
> (Sewell, 1981, p.20)

The researcher exercised considerable ingenuity in producing a set of "practical" or "functional maths" problems - as shown both by her attention to the representation of the context, e.g. in using documents and unsimplified numbers, and by her sense of the importance of the social relations of the interview, e.g. in attempting to reassure interviewees that it was not a "test", and in stressing that it was not required to attempt unfamiliar problems. Thus, Sewell's view of variation in "context" has moved beyond seeing it simply as to do with the wording of the problems - though it still remains limited basically to question format. Nevertheless, I shall draw on ideas from Sewell's interview methods when discussing my own (see Ch.9).

The problems themselves remained, in her view, firmly "mathematical". In the quotation above, she categorised their basis in mathematics much more systematically than in any conception of "everyday life". In addition, there was a hint of pathologising those who take "evasive action", rather than choosing to confront any problem as inherently "mathematical" (see also Dowling, 1991, p.103). It was the researcher who defined what were the "needs of everyday life" and who labelled them as essentially mathematical.

There have been rather more studies of adults' needs for numerate skills in work situations (than in everyday life); see APPENDIX W1. (NOTE 4)

Sewell's study and those reported in APPENDIX W1 have produced several interesting results; for example, the variety of methods used by subjects in work or everyday practices. In addition, there have been several developments in the idea of the context of numerical performance:

- a recognition of different values and goals underlying the use of "mathematics" in everyday, as compared with school, contexts, e.g. speed vs. elegance (see University of Bath (1981) and APPENDIX W1); and
- an indication of the differences in the language used by different groups to describe specific activities (see Harris (1991a) and APPENDIX W1). It has been the researchers who have termed the practices from work and from other everyday activities as essentially "mathematical", and the practitioners who have often not seen it that way. Indeed there were hints that those subjects who "failed" to see problems as mathematical were sometimes pathologised as "mathematics-avoiding".

The ideas on transfer here are still simplistic: practical tasks embody mathematics, so the mathematics must simply be recognised, and transfer will be basically straightforward. However, several examples have demonstrated the discontinuity between the ways activities are perceived and described by practitioners, and by researchers.

7.2 Ethnomathematics

Maier (1980) introduced the idea of "folk maths": whereas school maths (SM) is the particular type of maths taught and learnt in schools, "folk maths" (FM) is the maths "that folks do", which "consists of a wide and probably infinite variety of problem-solving strategies and computations that people use" (p. 21). For many people, SM is done only in the school context.

Maier's discussion pointed broadly to at least three dimensions of difference between the school maths and folk maths contexts. In terms of problem formulation, school maths tends to present pre-formulated problems, with the requisite data provided. Folk or practical problems are often not clearly defined, and the necessary information must be actively sought (p. 22). In terms of the level of precision used, school maths normally presents exact (and relatively simple) numbers and expects (often remarkably) precise calculations. Folk mathematicians need to be able to cope with estimation in measuring (including sometimes measurement error) and approximation in computation - that is, to make decisions on how much precision is appropriate for their purposes. Further, in terms of computation technology, school maths tends to prefer pencil and paper, whereas folk mathematicians often rely on mental computations and algorithms convenient for such use - or, these days, calculators.

For Maier, however, there was not only a distinction between FM and SM - there was a disjunction ! For school maths problems

> have little in common with that life [i.e. outside school]. They are school problems coated with a thin veneer of 'real-world' associations. The mathematics involved in solving them is school mathematics, of little use anywhere but in school.
>
> (Maier, 1980, p.21)

The problems "coated with a thin veneer of 'real-world' association" recall those I called "applied school maths" items in Chs. 5 and 6. Maier's early article thus laid the basis for seeing a disjunction between school maths and folk maths (or practical maths), and therefore for a new conception of numeracy.

D'Ambrosio (1985) developed the SM / FM distinction culturally and historically. He contrasted academic maths with "ethnomathematics", described thus:

> the mathematics which is practised among identifiable cultural groups, such as national-tribal societies, labor groups, children of a certain age bracket, professional classes, and so on. Its identity depends largely on focuses of interest, on motivation, and on certain codes and jargons which do not belong to the realm of academic mathematics. We may ... include much of the mathematics which is currently practised by engineers, mainly calculus, which does not respond to the concept of rigor and formalism developed in academic courses of calculus.... And builders and well-diggers and shack-raisers in the slums also use examples of ethnomathematics.
>
> (D'Ambrosio, 1985, p.45)

Here D'Ambrosio points to further differences between SM / academic mathematics, and FM / ethnomathematics: differences of interests, especially as related to social groups and classes, goals ("motivation"), and language ("codes and jargons"). He also points out that the differences between SM and FM are historically (and culturally) specific. (NOTE 5)

As with some of the utilitarians described in Sec. 7.1, the ethnomathematics researchers have carefully described a range of activities which may be seen as having numerate aspects. The writers on ethnomathematics have again indicated as dimensions of difference between contexts of numeracy:

- language: modes of presenting problems, codes and jargons; and
- goals ("motivation") and values, e.g. precision used.

And they have introduced new ones:

- social relations: basis in a social group, with interests, etc; and
- material resources, e.g. computation technology.

Paulus Gerdes (see APPENDIX W2) is concerned to assert the need for transfer of "mathematical" knowledge in both directions between academic mathematics and ethnomathematics. For Maier, it is seen as a great deal more problematical, because of what he sees as the disjunction between school maths and folk maths.

7.3 The Brazilian School

The school of researchers under the leadership of Terezinha Carraher, David Carraher and Analucia Schliemann (CCS) share similar concerns to those of the ethnomathematics researchers. CCS and their students have studied the everyday practices of various groups of workers in Brazil; e.g. carpenters, bookies, farmers, etc. (Carraher, 1986; Acioly and Schliemann, 1986; Abreu and Carraher, 1989). They have employed ethnographic description of the numerate aspects of the activities of these groups, but have also noted the shortcomings of purely ethnographic methods (Carraher and Schliemann, 1988); thus they have designed studies which use a mixture of experimental methods and Piagetian clinical interviews such as CCS (1987) reported below. It should be mentioned too that the interest in doing studies in Brazil is not only social, but also methodological: the variation in the number of years of schooling attained by the Brazilian population is much greater than in most European or North American countries.

One of CCS' early concerns was with social class differences in school mathematics failure (e.g. T. Carraher, 1988, p.1). When they began their research programme with an inquiry as to how children were actually solving problems outside of school, "in the street", they found that (i) children out of school had their own distinctive methods for solving "mathematical" problems; and (ii) when they were allowed to solve problems in their own ways, many of the social class differences disappeared (ibid., p.2; Carraher, Carraher and Schliemann, 1985). And when they compared the children's performances in street contexts with those in school-like testing contexts, the performances on what appeared to be "the same task" were superior in the street contexts.

The researchers so far discussed in this chapter have tended towards the view that, despite the difference in contexts, it is appropriate to talk about "the same task in different contexts". Yet a number of crucial differences between school and non-school contexts have already been pinpointed. In my view, the contexts across which CCS sought to compare cognition and performance - namely, street markets and testing in school settings - were so different that it was reasonable to ask whether what appeared to be "the same task" across different contexts really could be the same (e.g. Evans, 1988).

CCS (1987) took a different tack by asking which aspects of the different contexts could account for the differential performance across contexts. One reason they proposed was that the social relations between researcher and researched were different - indeed, the child working as street vendor may well not have realised that the "customer" was also a researcher. In this study, they controlled for such differences in social relations between contexts by presenting problems in three situations within one context: the context was testing-in-school, and the three situations were simulated store problems, word problems, and computation exercises. Problems set in each of these three situations were created using each of the four operations (+, -, x, ÷), matching for difficulty, and performances across the three situations were compared. CCS first found that the number correct was higher in the simulated store and word-problem situations than for the computation exercises. This could not be explained merely by the availability of concrete objects for the simulations, since the level of correct performance was equally high for word-problems, where none were used. They next found that correct performance was also correlated with the choice of procedure, with what they called "oral" calculations being done correctly more often than "written" ones. Further, they concluded that, when the procedure used by the children was controlled for, the differences in correct performance across situations disappeared. (NOTE 6)

For CCS, the difference between written and oral procedures is based on their being learned in school and in informal contexts, respectively; this difference also parallels the distinction between a "manipulation of symbols" approach, and a "manipulation of quantities" approach (Reed and Lave, 1979). The manipulation of symbols approach is based on the memorisation and recall of arithmetic operation facts, and the memorisation and use of algorithms which use written representation. The manipulation of quantities approach uses heuristics, such as decomposition (for + and −), and repeated grouping (for x and ÷) (CCS, 1987). Algorithms need to be memorised and relatively rigidly applied; heuristics are more flexible in general.

Thus CCS conclude that

> the situations in which arithmetic problems are embedded may have a strong impact on how they are solved. This impact is not produced by some peculiarity of the testing situation, such as anxiety, but seems to result from the meaning that problems have for children when they engage in problem solving.
>
> (Carraher, Carraher and Schliemann, 1987, p.95)

and

> The effect of the situation upon the child's performance is mediated by the choice of strategy.
>
> (T. Carraher, 1988, p.5)

Situations that present quantities embedded in meaningful transactions allow children to preserve meaning in problem-solving procedures, because of the physical quantities that are being quantified (e.g. money, cars), and because the meaning of the quanitifier itself within the number system (e.g. ones, tens, hundreds) is preserved. On the other hand, written, school-based procedures, which involve the manipulation of symbols may lead children to focus not on physical quantities and preserving meaning, but on written numbers and rules; since these rules may be designed to convey meaning in abstract ways such as through place-value, they may be experienced by the learner as being associated with a loss of meaning. This may explain some learners' apparent willingness to accept results that would be recognised as absurd by anyone who was "controlling for meaning".

On the basis of their wide-ranging ethnographies in other studies, CCS describe some of the heuristics that allow people to accomplish arithmetical calculations while conserving meaning; for example, besides decomposition and repeated grouping (see above), "rated addition" for proportional reasoning is described (T. Carraher, 1986).

The group is fairly optimistic about the possibility of transfer:

> For the great majority of mankind, it is likely that practices, representations [e.g. the actual words for numerical operations such as 'taking away', 'times'] will have some bearing on how mathematical [sic] problems are handled outside of school. It also seems resonable to suppose that one's experience in working with mathematics [sic] outside of school will play an important role in how one understands mathematics taught in school.
>
> (D. Carraher, 1991, p.171)

This quotation seems to suggest that the ideas remain constant as "mathematics", whether in school or informal contexts. However, CCS' use of Vergnaud's theory of concepts can be seen as an attempt to deal with the problem of whether the ideas "really are" mathematics. In Vergnaud's model (e.g. 1988), concepts (as they are developing in a learner's mind) are seen always to have three aspects: invariants, representations and situations. Invariants refer to the properties or relations associated with the concept, e.g. symmetry, commutativity, conservation of equality. Representations are based on the set of symbols (linguistic or non-linguistic) and are used to communicate or discuss invariants. Situations make the concept meaningful; the idea "appears to be broad enough to include" social situations (e.g. selling, sporting events, maths classes, testing) and real or imagined problem-situations (e.g. "times problems", proportionality problems) (D. Carraher, 1991, p.178). This triple aspect of mathematical concepts allows CCS to argue that the invariants must be constant across thinking in different contexts, whereas the representation and especially the situation depend on the context. Thus in CCS (1987) above, the situations for maths problems were separated out as store simulation, word problem, and computation (what were called "backgrounds" in Ch.6), and one facet, at least, of the representation was oral or written procedures.

Thus, CCS seem to have reformulated the problem of transfer: though the invariants may be the same between school maths addition and totalling prices in the market, since the situations and the representations are different, the concepts are not strictly the same (D. Carraher, 1991, p.178). Thus neither the gap in performance between market and testing contexts (CCS, 1985), nor that between store simulation or word problem, and computation, situations (CCS, 1987) provide a refutation of the possibility of transfer of learning; rather, the differences arose because the subjects perceived that different procedures were "called for" in the different contexts or situations (CCS, 1987).

In some of their other studies, transfer is measured in terms of correct performance in solving problems constructed by the researchers. Typically, the first set of problems are based in the work context, but are "beyond" the familiar situations (i.e. problem-types or tasks); the researcher then negotiates the participation of the worker in attempting later sets of problems which are administered in a sort of out-of-school testing context. (This move into new situations entails an "extension" of the concept in Vergnaud's terms.) This methodology was used not only in CCS (1985), but also, for example, Acioly and Schliemann's (1986) study with bookies in the local lottery, and Carraher and Schliemann's (1987) study of market sellers' facility with the manipulation of equivalences in volume or weight.

In Acioly and Schliemann (1986), a link was found between the number of years of schooling of the bookies, their use of school algorithms, and correct performance on the constructed tasks. The researchers concluded that

> The contribution of everyday practice is evident in the invention of rules and computation strategies as well as the memorisation of facts - that all provide short-cuts. [...] The contribution of school instruction was not found in the use of school algorithms, but rather in a more general ability to analyze and understand relationships between the elements in the game.
>
> (Acioly and Schliemann, 1986, p.226)

They also noted that the subjects used informal procedures <u>together with</u> modified taught school procedures. Similar "syncretic" procedures have been reported among African children by Brenner (1985), and with New Guinean children by Saxe (1991a).

The CCS research has made a very substantial contribution to efforts to describe cognition in context - through their seeking out and description of numerate thinking in a wide range of work contexts. However, the "experimental" phase of their studies has emphasised the "situation" (rather than the context). And this move has limited the capacity of this research to study cognition in context, fully understood: being tested in the simulated store situation is not the same as functioning in the market context.

CCS's use of the distinction between oral and written procedures in calculation is practical - the basis of the distinction is overt - but it can also be deceptive (NOTE 7). Further, as suggested above, some examples of problem solving may combine both sorts of procedures. In any case, CCS make it clear that the substance of the distinction is based in the context where the methods were learned - in school or out of school - rather than simply in the overt character of the procedure. Thus this difference in procedure is not sufficent to capture fully any differences in context.

7.4 Socially Organised Activity

In this section, I discuss a group of thinkers whose work has been characterised by an interest in the work of the Soviet psychologists Vygotsky and Leontiev, and who have approached the issue of context through the idea of socially organised activity. One of their early concerns was the "ecological validity" of many psychological research findings; see sec. 7.4.1.

Researchers working in this broad programme have also produced a number of cross-cultural studies, e.g. those of schooling in mathematics (e.g. Gay and Cole, 1967; Brenner, 1985), the work of tailors (e.g. Lave, 1977) and candy-sellers (e.g. Saxe, 1991a), and various forms of literacy in everyday life (e.g. Scribner and Cole, 1978) that inform the work reported on here. This programme also has produced studies of out-of-school cognition in industrialised society, e.g. Scribner's (1984) study of dairy workers described in sec. 7.4.2 and Lave's (1988) study of shoppers described in sec. 7.4.3.

7.4.1 Task and context: Michael Cole et al.

In most of the approaches discussed so far in this chapter, cognitive tasks are situations created (normally by researchers, teachers or testers) to elicit behaviour from learners - for purposes such as promoting learning, or assessing learning or thinking skills. It has normally been assumed that the task can be specified succinctly in writing or orally, and - in some of approaches at least - that any other aspects of the context can be assumed to be relatively unimportant, e.g. for the purposes of transfer of learning.

The second assumption concerns the ecological validity of cognitive research, i.e. the extent to which its findings can be generalised beyond the laboratory contexts, and the specially designed tasks, on which they have been based, to less contrived everyday settings; see Cole, Hood and McDermott (1978) for an extended discussion. The parallels between the methodological issue of ecological validity, and the substantive issue of transfer of learning from school settings to everyday settings, have been noted and discussed, especially by Lave (1988).

The first assumption - that tasks can be identified (and that they can be classified as mathematical or not) - is found in work based on conceptions of numeracy N0 and N1. It clearly has implications for any notion of context. Michael Cole and his colleagues have addressed the problem of defining a task. This is to be undertaken partly by specifying certain "design features" of the setting (Cole and Traupmann, 1979, pp.33ff.); see APPENDIX W3.

As Cole and Traupmann point out, the design features of tests and experiments (see APPENDIX W3) tend to facilitate the identification of errors. To provide a contrasting setting, the research group set up an after-school cooking club, where the children's behaviour could be observed and recorded. The goal in the club was different from that of the testing situation: people came together to cooperate on a task, e.g. to bake a cake. (NOTE 8)

The discussion in APPENDIX W3 points to ways to extend the notion of context being developed here. In general terms, they suggest that instead of thinking of an abstracted task, or a concrete context, we need to think of a "task-in-context" - which is characterised by goals, including "higher-level" ones, which may not be under the control of particular actors. More specifically, they point to the possibility that a subject may be attending to more than one task in a particular setting. And an important feature of the task-in-context may be the extent to which the social relations of hierarchy, power, etc. leave the subject free to attend to, to reformulate, or even to ignore, the task / goal that is the focus of the researcher's attention. Finally, it cannot be assumed that a task resembling any particular school-type task will actually be performed in any out-of-school context: it must be researched, preferably using some form of ethnographic observation and description.

7.4.2 Activity and goal-directed action: Sylvia Scribner

Sylvia Scribner's writings provide some of the most explicit exposition in English on the scope and meaning of activity theory. For example, "activities" are:

> enduring, intellectually planned sequences of behavior, undertaken in the service of dominant motives and directed toward specific objects.
>
> (Scribner, 1985, p.199)

They can be analysed on three levels - as activities (e.g. work activities, play activities), or in terms of the goal-directed actions that comprise them, or the specific operations by which the actions are carried out (p.200). Again the goal-directed quality of activity is emphasised. The three levels in the hierarchical organisation of an activity (NOTE 9) can be illustrated in Scribner's research on work in the context of a dairy (milk processing plant) (e.g. Scribner, 1984). Here, the various occupations employed in the dairy could be considered as socially organised _activities_; examples of goal directed _actions_ would be specific work tasks, such as assembling a customer's order or pricing a list of deliveries; and these would be based on _operations_ such as taking six quarts of skim milk from a case, or multiplying a unit price times a quantity (see also APPENDIX W4).

The study involved first an intensive ethnographic description of the tasks engaged in by various dairy employees, notably blue-collar (manual) workers. This was followed by an experimental phase where actual and simulated tasks were given to various groups of employees, e.g. those assembling orders in the warehouse, delivery drivers and clerical workers, plus students from a nearby secondary school.

We cam sum up the contributions of Scribner et al.'s research; see APPENDIX W4 for fuller details. They relate expert or skilled performance to the following:

- _familiarity_ with the tasks, or with similar ones;
- a greater knowledge and _repertory of strategies_ (see also the discussion of the work of CCS in Sec. 7.3); and
- a consequent _flexibility_ and _efficiency_ in response to the perceived task demands (at least in an industrial setting).

The knowledge and strategies used by such "experts" are meaningful in that much of the former is domain-specific, and many of the latter remain in touch with "the things that numbers signify". (This, too, recalls Reed and Lave's (1979) discussion of the "manipulation of quantities", as distinct from a "manipulation of symbols" approach.) Finally, it is argued that increased proficiency in practical settings takes the form of acquiring _specialised_ functional skill systems, rather than increasing the _abstraction_ of a single system (Scribner and Fahrmeier, 1982, pp.43-44). Thus the position taken by this research clearly diverges from the commonly argued view of transfer.

7.4.3 Arithmetic in everyday activity: Jean Lave et al.

This section summarises the main ideas underlying Jean Lave's work, and her most pertinent research. Further details locating her work, and reviewing a broader range of findings, is found in APPENDIX W5.

(a) Lave's ideas and research

For Lave (1988), activity forms what we might call a "dialectical triple" with "persons-acting", and the context or situation. (NOTE 9a) Cognition in everyday practice is "distributed" or "stretched over - not divided among - mind, body, activity, and culturally organised settings (including other actors)". Thus, "the _specificity_ of arithmetic practice within a situation, and _discontinuities_ between situations, constitute a provisional basis for pursuing explanations of cognition as a nexus of relations between the mind at work and the world in which it works." (1988, p. 1, emphasis added).

In exploring the idea of context, Lave proposes a number of dialectical relations that are meant to transcend the polarities mentioned earlier. She distinguishes the _arena_, a durable public context such as a supermarket, and the _setting_ which is malleable and is as experienced by the person-acting; thus a supermarket is an arena which offers a setting for a particular shopper's weekly rounds. At a macro level, there is a relation between the _experienced world_, which is made up of the relations already mentioned, and the _constitutive order_, which itself relates "culture" (semiotic systems) and "material and social organisation" (including political economy and social structure). (See her diagram on p. 177.) Lave calls the constitutive order the "context of the context", and indeed the whole structure seems a valuable way to begin to characterise activity in context, _and_ its relationship to larger structures.

In exploring activity in context and its larger relationships, Lave uses a term which has some affinity with "activity", in Scribner's sense of being fundamentally goal-directed and made up of knowledge, strategies and technologies including symbol systems - namely, structuring resources. These have as their basis: not only ongoing activities; but also social relationships; subjective experience of problems as dilemmas, thereby producing motivation; and standard crystallised forms of quantity such as money and mathematics (1988, Ch. 6). Thus, when Lave speaks of "proportional articulation of structuring resources", she means the relative predominance of different practices (NOTE 10) in shaping actual activity in the particular situation. This allows her to conceive of a different "mix" of "shopping" and "maths", say, in the supermarket and in her "best-buy simulation experiments" (see 1988, pp.99ff.) (NOTE 11) Lave also argues that doubts about the ecological validity of experiments pose questions about the articulation of structuring resources in experiments and other settings (p.100).

This idea of a person's being involved in more than one activity at once recalls the idea of a subjects's responding to more that one task at time (as in the discussion of the work of Cole et al.). It emphasises the problem of how the person knows or "decides" which activity (or which mix of activities) they are "acting within" at that time - as well as the problem of how the researcher would know. Lave's work displays the difficulty of this problem. Consider the following discussion of the differences between her results on best-buy simulations and those of Capon and Kuhn (to be described below):

> Subjects find themselves in one situation, an experiment, while there are signs that they are expected to act as if they were in a different situation, e.g. grocery shopping. [...] conventional experimental practice bars experimenters from explaining their intentions to subjects who are thereby left to guess them. [...] here subjects seemed to draw similar conclusions about the predominant structuring resources shaping a particular experiment, but differed sharply between [Lave et al.'s and Capon and Kuhn's]

experiments, reflecting differences in their structure quite accurately.

(Lave, 1988, p.115)

This problem is a major focus of this chapter, and of this thesis. (NOTE 12)

Lave echoes many of the criticisms of the concept of transfer, and of transfer experiments, discussed earlier. (NOTE 12a) The "problems" presented are considered as objective and factual, because they are constructed by experimenters, rather than by subjects, and the experimenters preformulate the correct or appropriate solutions. This has two consequences: a subject who does not take on the problems, or who does not produce the appropriate solution, is deemed to have "failed"; and the researcher is unable to study the fruitful methods the subject may have to deal with certain problems. Therefore, such research fails to describe much observable problem-solving activity.

Lave's empirical material comes from the Adult Math Project, which began in 1978, and involved Michael Murtaugh (1985) and Olivia de la Rocha (1985). Lave chose arithmetic as the focus for this research, as it "has a highly structured and incorrigible lexicon, easily recognisable in the course of ongoing activity" (1988, p.5). However, we shall wish to question both its supposed "incorrigibility" and its "recognisability", at various points in this thesis.

The research studied a sample of 35 Californian adults, especially their involvement in shopping activity or dieting. Further details of methods and results is given in APPENDIX W5.

From these results Lave drew several conclusions about how activity may be constituted in context-specific ways (1988, pp.68ff.). First, there is a <u>discontinuity</u> in performance, in terms of accuracy and procedures used, between (what Lave still calls) "maths" performance in the supermarket on the one hand, and in test activities on the other. It may be suggested that the discontinuity was due to the context of the activity, because of two of the results reported in APPENDIX W5: the substantial (and "unexpected") differences in correct performance in the two situations, and the observable contrasts in the way the two sorts of activities were performed. However, it should be noted that the discontinuities, at least in the content of performance, were not all that clear; for example, was the "measurement facts" set of questions firmly in the school maths category, or intermediate between school maths and practical performance?

The "salience" of arithmetic activity (i.e. actions and operations), in terms of the structuring resources, varies across settings. It tends to be high and relatively constant in certain experiments (and tests and school lessons), and it tends to be variable, and normally lower, in everyday settings such as the supermarket. Therefore, the postulation of different saliences (or different proportions of structuring resources) allows for a whole range of "mixes" of activity. Hence it enriches the type of answer that can be given to the question at the end of the previous paragraph. (But it then raises a question about the meaning of the "discontinuity" in performance.)

There is also a question about the relations between problem solver and problem. We have noted that Scribner and Fahrmeier (1982) see problems as existing objectively in contexts, with a consequent binary classification into school and work maths. Lave argues, however, that the shopper can choose to recognise a problem - or not (p.69) (as often the children could in Cole et al.'s cooking club); this must mean that both the context and the thinking subject must be involved in "locating" the problem. The apparently different conclusions of the two teams may well be related to the differing positionings of work, and shopping in the "constitutive order" (see above): the dairy loader seems normally to have to do <u>something</u> in response to an order, whereas a shopper seems to be more free, say, to choose an item on their list without doing a calculation, or even to ignore the item.

The way in which situations, occasions and activities are inter-related must shape arithmetic in practice. For example, the frequent use of decimal/fraction conversions and ratio comparisons by sample members is understandable, given the need to compare and convert amounts of materials between settings, e.g. between supermarket and kitchen.

(b) Best-buy studies

Here I examine more closely the best-buy studies (supermarket observation and simulations) reported in Lave (1988), and the studies done by Capon and Kuhn (1979, 1982). They differed in several crucial ways. First, Capon and Kuhn were working within a Piagetian developmental framework, so that the subjects' response strategies were <u>ranked</u> by them in terms of proximity to formal operational reasoning; see Table 7.1(p.459).Capon and Kuhn considered strategies (5) [comparison of the quantity and price ratios] and (6) [comparison of unit price ratios] to be "conceptually correct", with (5) less generalisable than (6). They considered strategies (4) [differencing] and below as not "conceptually correct".

In contrast, Lave et al. in the AMP aimed to avoid Capon and Kuhn's "normative" approach, by classifying the subjects' strategies without ranking them. They added a further strategy (7) "inspection" - simply looking at the prices and quantities to see if there was one "best buy" that was obvious, in the sense of giving more quantity for the same price, or the same quantity for a lower price, than the alternative(s). Lave et al. also categorised the questions into <u>types</u>, according to which strategy they judged to be the most "appropriate" (straightforward numerically) to use from among (5), (6) or (7). They were expecting subjects to respond <u>flexibly</u>, i.e. to use a strategy "appropriate" for the problem "type". (NOTE 19a).

Second, the methodology was different, and so were the results; see APPENDIX W5. Lave argues that Capon and Kuhn's a priori, normative model of how maths should be used in practice, and her own attempt to describe ethnographically how it is used, led generally to differently structured, and differently interpreted, activity in the two studies.

In comparing results from the two studies, we must first note the difference in primary focus. For Capon and Kuhn, it was "conceptually correct" performance, or strategy use; for Lave, it was correct answers, though she reports both. Therefore, comparisons of performance in the two studies must focus on strategy use. The basic difference was between Capon and Kuhn's report of 55% of responses on their two problems "conceptually correct", i.e. using strategies (5) and (6), and the 86% of Lave et al.'s subjects doing so on their eight "P/Q ratio" type problems (91% giving the "correct answer" - NOTE 17a).

Lave's explanation for the difference is that Capon and Kuhn's experiment was interpreted by subjects as a test, whereas, for the AMP best buy problems, subjects concluded they were expected to act more or less as in shopping (Lave, 1988, p.115, quoted in subsection (a) above). Thus she would expect the sorts of performance differences between test and "everyday" situations reported by Carraher et al., by Scribner, and by Lave herself. (NOTE 18) But this still begs the question as to why these different situations are associated with different levels of performance. (We could say that Capon and Kuhn's research "called up" the practice of school maths tests, and Lave's called up supermarket shopping; see Ch.10.)

There are several other possible explanations for the higher level of "conceptually correct" performance in Lave's results. First, differences in difficulty: I judge Capon and Kuhn's two problems to be broadly comparable with Lave's two most difficult. If this judgement were accepted, then the difference between the two studies' results would be cut in half - to 55% vs. 70% conceptually correct. (NOTE 18a) Second, with 12 best buy questions in all, and eight of one type, there may have been practice (or "familiarity") effects in Lave's study.

There might also be differences in the social relations between researchers and researched, and in subjects' affective reactions to the research situation - sometimes called "reactive effects". Whereas Capon and Kuhn's team would have spent no more than 5 or 10 minutes per subject (n=150), Lave's spent about 40 hours with each (n=24). There cues might well be communicated from researchers to subjects (cf. Sec. 5.2), and mutual commitment built up; also, Lave's team offered to "help with calculations"; see APPENDIX W5. All this could have helped Lave's subjects' performance.

Differences in interpretation are crucial. Capon and Kuhn had two strong preconceptions: first, they saw strategies (5) and (6) as appropriate for <u>all</u> such best buy problems; and second, they saw the strategy (or strategies) chosen for their two questions by a subject as indicating his/her fixed "developmental competence". Lave et al., like Scribner, saw subjects as choosing flexibly and appropriately.

There is much support for Lave's claim for <u>flexible</u> strategy use. Capon and Kuhn (with only 2 questions) reported 69% of subjects as using one strategy, and 31% using two strategies; AMP, however, using 12 questions, found half of the subjects to use three strategies, and half to use four. There is also support in the data for the view that subjects matched strategies <u>appropriately</u> to problem types. (NOTE 19) However, these judgements about what is "appropriate" strategy use by Lave et al. are just that: they might not be right, and they do themselves have a taste of the "normative". (NOTE 19a)

Lave also notes the differences between the first two simulation experiments and the supermarket observation (see Table 10.7(a)) but cautions against over-interpretation, since she has earlier shown that strategy use is related to numerical difficulty of the problem (NOTE 20a). Nevertheless, she notes a lower proportion of unit-price (6) calculations in the supermarket, and a higher proportion of difference (4) calculations. The difference calculations are interesting in that they represent a "marginal utility" type of reasoning of the form ..."I get 2 oz. more for 6c; is it worth it?" She argues that this is not a problem for which there is a purely numerical solution:

> ... the elements (prices and quantities) and relations (ratios and comparison of ratios) of a unit-price calculation have more salient relations elsewhere than with each other. Prices are compared with alternative uses for marginal sums of grocery money and quantities ... are compared with concerns about managing food.
> (Lave ,1988, pp.119-120)

She lists several possible concerns: storage capacity; rate of usage; and rate of spoilage, etc. These all seem related to quantity concerns. Price concerns may be related to social class position; see the analysis of my interview Qu.6 in Ch.10.

In summing up, we might say that Capon and Kuhn are normative in general, in that they expect strategies (5) or (6) to be used for any question. Lave, for her part, is normative in particular, in that she expects an "appropriate" choice of strategy, efficient for the question at hand. Neither research seems to allow that performance might relate to the wider aspects of the context. For example, Capon and Kuhn's study made available pencil and paper only, but no calculators, though this computation technology was widely available in late-1970s USA. And, though Lave refers to ecological validity, she does not discuss the effects of the rather special social relations in her study.

Capon and Kuhn's insistence on seeing unit price reasoning (strategy (6)) as the pinnacle of logical reasoning - and the choice of other strategies as inferior (5), or as downright failure (all others) - is especially limiting. They do not allow that such a choice might come from a realisation that another approach e.g. comparing price and quantity ratios, might be more convenient to calculate, or from an evaluation that it is not worthwhile to base a particular decision on prices and quantities, or from a general position that ignores all but the grossest aspects of value for money. (These three positions are illustrated by various subjects in my interviews; see Sec. 10.4 below.)

(c) summary and evaluation of Lave's work

Lave's work has contributed a number of valuable ideas to the concerns of this chapter. First, she has developed the idea of context as having aspects of an "arena" (relatively durable) and of a "setting" (as experienced by subjects). She uses the idea of structuring resources, and their "proportional articulation", implying that a subject generally has a position in a mix of activities. She also argues for the idea of a "discontinuity" between school maths and maths or numeracy in everyday activity - and the critique of a straightforward "transfer" of learning.

Concerning problem solving activity, against the "normative" perception of there being "one correct method" (NOTE 20), she proposes a shift in its conception "from a value free, context free technology of means, to a value laden, conflict driven situationally-specific direct form of experience". She uses ideas of the early formulation of a "solution shape", with "gap-closing" in the resolution of "snags" or dilemmas (1988, pp.139-142 and pp. 158ff.) The ease of formulating "solution shapes", as well as the availability of developed strategies (p.129), suggest aspects that might give substance to the idea of familiarity (or expertise in Scribner's terms) discussed earlier; see also the analysis of the interviews in Chs. 10 and 11.

However, there are limitations in Lave's ideas on context and activity-in-context. The idea of the "proportional articulation of structuring resources" sometimes appears imprecise. (NOTE 21a) Lave's arguing, for example, that her best-buy simulation problems attempted at home were structured similarly to her observations of decision-making in supermarket shopping (1988, pp.114-5) risks not only underplaying their differences, but also investing both with a specious "naturalness" or "practicality" while ignoring the distinctive aspects of both as research contexts - in terms especially of social relations, including "norms", and language / discourse. This suggests a need to develop ways of determining more clearly which activity (or mix of these) the subject is "in" (or has called up), when confronting a specific problem. Also, in her macro analysis, many of the relations remain unclear, e.g. the relationship of "culture" and "material and social organisation" to "persons-acting-in-context". (NOTE 21) There are also some gaps in her work: for example, there is little discussion of affect, and little on gender and social differences.

Walkerdine's work, to be discussed in the next section, offers ways to make good these gaps and limitations.

7.4.4 The structure of everyday activity: Geoffrey Saxe

Geoffrey Saxe (1991a, 1991b) has studied candy selling among children (5 - 16) in NE Brazil, as an everyday practice; see APPENDIX W6. His theoretical framework has several components. At the centre are the seller's emergent goals (emerging during participation in the practice of candy-selling), of which Saxe chooses to focus on the "mathematical" ones; these seem to correspond to tasks or actions in the activity / action / operation hierarchy (see sec.7.4.2). These are influenced and constrained by four "parameters". The first is the activity structure of the practice, the general motives for participation in selling and the types of tasks that must be accomplished (cf. "high-level goals" referred to by Cole et al.; see sec. 7.4.1). Saxe takes this analysis further than others, in his description of the candy-selling practice as involving the cycle: purchase / preparing to sell (pricing) / selling / preparing to buy.... The emerging goals are also conditioned by the related social interactions: wholesalers or fellow sellers (or family members) may provide help in pricing, and customers in making change. Another aspect of the activity-in-context include the cultural artefacts - e.g. currency denominations and inflation, conventions - e.g. boxing of candy and price ratio selling prices, and sign forms - e.g. the number symbols, "currency arithmetic". Finally, the individual's prior understandings will condition emerging goals.

Saxe's "parameters" recall Lave's "structuring resources", but they are discussed much more systematically - especially the activity structure of the practice. Of course, it may be easier to discuss such "form - function" issues in the case of work practices, because of the relatively high "discipline" there (recall the comparison of Lave and Scribner's work in sec. 7.4.3 (a)) - and this tendency may be even greater here, with the relatively simple buy / sell structure to the practice.

On the issue of transfer, Saxe is more positive, and less polemical, than Lave (Pea, 1990). He is interested in "the interplay of form and function across cultural practices". For example, he describes how a seller (aged 13, 5th grade completed) carries out the pricing function in the candy selling practice - determining the wholesale unit price by trying out several possible values, each time using a standard school multiplication algorithm. He then calculates his profit per candy bar, and hence per box of 50 - using school algorithms for subtraction and multiplication (though Carraher et al.'s researches have taught us to look for decomposition and repeated addition as possible alternative methods) (1991a, p.61). Saxe conceives of transfer as "an extended process of repeated constructions [...] of appropriation and specialization" - rather than as an "immediate generalization or alignment of prior knowledge to a new functional context" (1991b, p.235).

Thus Saxe's position on transfer recalls Scribner and Fahrmeier's emphasis on "specialised functional skill systems", rather than one abstract system. Like Lave, he emphasises the importance of repeated attempts for transfer to take place, the importance of social (or pedagogic) supports, and some depth of knowing the specialised knowledge forms involved in solving practice-linked problems, in order for them to be appropriated and transformed.

7.4.5 Summary and developments

Those working under the broad banner of activity theory have emphasised the importance of <u>goals</u> - both at the level of the activity ("higher-order" goals), and at the more specific level of actions. We can now see problem solving (or task completion) as a "value laden, conflict driven, situationally specific" process (Lave). Familiarity or expertise in a practice results in <u>flexibility</u> of response, and therefore <u>efficiency</u>, towards the demands of the task. Expert response is thus seen to differ from the schooled response which would tend to attempt to use the same algorithm for a variety of tasks in a variety of situations. Familiarity in this perspective can be seen as engagement with the practice in a way that supports and motivates these processes.

The application of the ideas of activity theory to mathematics education have been addressed in wide-ranging discussions in Mellin-Olsen (1984, 1987, 1990) and e.g. Crawford (1992). Mellin-Olsen, in seeking to explain why so many students are turned off school, and especially school maths, brings the concepts of oppression and resistance, to his overall conception of activity: oppression consists of being denied access to activity having goals with which the individual is engaged (1987, pp.30ff.). Drawing on psychoanalytic ideas, he further argues that oppression may lead to distorted behaviour and repression (pp.163 ff.). This points to issues about subjectivity and affect which will be discussed more fully in Ch.8.

On the issue of what is a "practical" problem, he develops a useful pair of criteria: for a problem to be practical, it must "have a purpose", and it must be one that the student is "likely to face" (1987, pp.51-52). This leads him to suggest as an overall strategy that the mathematics curriculum should begin with folk maths problems that are practical, in the sense above; he discusses many examples. I shall return to some ideas of curriculum strategy in Ch.12.

However, although language, "sign systems", etc. are mentioned by most of these researchers, there seems to be lacking a systematic way to characterise the effects of language in different contexts. The other main gaps still apparent are an inattention to affect (except for Mellin-Olsen's pointers), and a lack of discussion of of social differences, such as gender and social class, although social class, for example, is alluded to in Scribner's work, and in the Brazilian School's (Sec. 7.3).

These three areas - language, social difference, and affect - will be taken up in the next section, though most of the discussion of affect will be in Ch.8.

7.5 Post-structuralism: Valerie Walkerdine

Valerie Walkerdine's work has ranged across child development, mathematics education, and cultural studies more broadly. In particular, she has studied the importance of language and "discourse" in learning, on social difference and oppression, especially gender and social class differences, and on the pain, anxiety and anger that form part of the "lived experience" of these differences (e.g. Walkerdine, 1990b). Here, I focus on the series of empirical studies of gender differences in the learning of mathematics at primary and secondary school, done with other members of the Girls and Mathematics Unit at the University of London Institute of Education (e.g. Walden and

Walkerdine, 1982, 1985; Walkerdine and Girls and Mathematics Unit, 1989); and on certain theoretical statements (e.g. Henriques et al., 1984; Walkerdine, 1988). Walkerdine's position can be labelled post-structuralist; its main tenets are outlined below and in Sec. 8.4.

Walkerdine's early work criticised the notion of "context" used in Piagetian and post-Piagetian work (e.g. Donaldson, 1978) as something which "is external to, and exists in an additive relation to, thinking" (Walkerdine, 1982, p.131). Language, cognition, and context must not be seen as separate systems (as in the views being criticised, or in views of numeracy as N0 or N1 - see Sec. 7.1); language (or cognition) must not be understood in a narrow, a-social way. For example, to understand the relation of the actions and vocalisations of a new-born baby to the actions and decisions of the parents, we have to understand

> what sense they make of its cries, and what this sense suggests as courses of action. [...] to understand their actions and their 'discourse' we do have to look at action, at gesture, at sound, at word; but we [..] must also include current thinking and writing, fashions etc. about feeding, mothering and so on. There is a historical and social dimension which we must include [...] It is the positioning of their discourse in relation to a number of other discourses and practices which enables us to make sense of its functioning in the process of signification. These discourses and practices are not the context but actually have a constitutive effect.
>
> (Walkerdine, 1982, p.132)

Thus, different contexts are characterised by - indeed, are "constituted" by - different practices and related sets of terms and meanings ("discourses"): these practices can be called "discursive practices" since they are based in, and regulated by, language. (NOTE 22) "Regulation" means subjecting some one (or something) to rules and standards of evaluation; how this may work and the differences of meanings across home and school contexts is illustrated by the following:

> Mathematical meanings - indeed, the development of language and word meanings in general - cannot be separated from the practices in which the girls grow up. The mother is positioned as regulative in these practices, in which desires, fears, and fantasies are deeply involved. So "mathematical meanings" are not simply intellectual, nor are they comprehensible outside the practices of their production. Yet in school [...] children have to learn that there are special meanings to these terms, which are not necessarily those used at home. [...] [In] the transcripts of recordings of thirty mother - daughter pairs [..] while there were many examples of "more", "less" did not occur once. [...] all instances of "more" come from mother - daughter exchanges where the daughter's consumption of scarce or expensive resources and food is regulated by the mother. [...] The opposite of "more" in food regulative practices is something like "no more", "not as much", and so on. [...] Here these terms, for the girls [..] carry strong emotional [..] content and act as signifiers in very different [ways] from the word pair "more" / "less" as used in school mathematics. [...] Shifts from these practices and emotions to understanding "mathematical terms" [..] have to be accomplished.
> (Walkerdine and Girls and Maths Unit, 1989, pp. 52-53)

Here I need to introduce some relevant terminology from linguistics. First, a linguistic <u>sign</u> is considered as the unification of two elements: a <u>signifier</u>, which may be thought of as the word, or symbol, or gesture (or, say, part of a drawing); and the <u>signified</u>, which may be thought of as the concept or mental image (but not the "thing itself") to which the signifier relates (de Saussure, 1974 and Hawkes, 1977, pp.19-28). In the example above, the same signifier "more" is linked to two different concepts (or chains of concepts) in the two discourses of school mathematics and the consumption of food, etc. at home. That is, the <u>meaning</u> of the term "more" is different within the two discourses.

Thus the relations on which the structure of language are based - the signs - are in a sense arbitrary. Further, the process by which linguistic signs and utterances are formed is based on two dimensions: the <u>combination</u> of words in a chain in a "horizontal" movement, and the <u>selection</u> of a word for a particular position in the chain, from those available, in a "vertical" movement. This two-fold process is underpinned by two ways of relating words as "equivalent" - metonymy and metaphor. <u>Metonymy</u> is based on relations of contiguity, and is the mode of the combinative dimension of language. <u>Metaphor</u> is based on relations of substitution or analogy, and is the mode of the dimension of selection (Hawkes, 1977, pp.76-79). Examples can be given of the way these two rhetorical "figures" convey meaning. The metonymic phrase "The White House considers ..." proposes an equivalence between a specific building and the President of the United States; the metaphor "My boss steamrollered me ..." proposes that the boss has an equivalent effect to that of a particular machine.

Returning to the quotations above, the particular practice or mix of practices in which subjects are engaged, <u>positions</u> the latter within that practice (or mix). Thus, the parents in the first quotations are positioned as "the carers" in child-care; in the second, the mother is positioned as the one who must regulate the child's consumption in eating at home. To take a different example, relevant to the interviews analysed in Chs. 10 and 11 below, in the practice of "eating out", being the one(s) who pay(s) is determined in many contexts in a complex interplay of gender and age positioning, as well as certain ploys, etc. Clearly, power is implicated in the positioning of subjects in social relations - as are oppression and resistance; however, power is worked out in relations at the micro level, not conferred by positions in a predetermined way (Henriques et al., pp.115-18).

The last illustration shows too that positioning may depend on social differences, e.g. gender or social class. For example, there may be strong social class differences in terms of how much money is available, and how it is handled: many working class families need to regulate the spending of money and consumption generally, while middle class families may be freer to allow choice in consumption, and to make calculations around money into a game, for the children at least; Walkerdine has called these relationships with calculation ones of "material necessity" and "symbolic control" respectively (1990b, p.52). Thus children from different social class backgrounds may be positioned very differently in practices which include calculation tasks.

As for gender, the discourses of primary school maths teaching and "child-centred pedagogy" (Walkerdine, 1984) tend to view as laudable "active learning", "breaking set", etc. and to view as pathological "rote-learning" and rule-following. But these ideas are <u>gendered</u>: girls tend to be positioned in the social interactions of the classroom as neat, helpful, hard-working and well-behaved - and then their production of behaviour consistent with such "characteristics" tends to be <u>read</u> <u>as evidence</u> of their passivity, in contrast with boys' naughtiness and restlessness in the classroom - which is seen as testifying to their "potential", "mathematical flair", etc.: here Walkerdine offers evidence from her empirical studies in schools (e.g. Walkerdine et al., 1989). We can note that many of the adjectives used in these gender "stereotypes" purport to be descriptive, but they actually tend to be <u>productive</u> of meaning <u>and</u> of performance !

Walkerdine also puts these ideas into historical perspective, drawing on the work of Foucault (1977, 1979). on the description of discourses and of the "subject-positions" within them. Though the ideas above can also be seen to relate to relatively recent discourses, they also relate to ideas from the last century - and earlier - that held women to be excessively swayed by emotions and therefore lacking in capacity for rational judgement. These ideas live on in today's "common sense" that "women's minds" are not fertile ground for mathematics and the "hard" sciences (Walkerdine et al., 1989, Ch.3). These points are further discussed in the next chapter.

The way a person is positioned will determine and delimit, to a great extent, his / her subjectivity. The determinations and limits of subjectivity are still very much a focus of debate in the social sciences and philosophy (NOTE 23), but we can understand subjectivity as including thinking and emotions, and what traditional psychological discourses call "abilities", "attitudes", "personality and "identity". Nevertheless, while people are positioned as described above, they appear to be free within limits to interpret a particular task / situation in a variety of ways. For example, Winter (1987) reports a study which used systematic observation of his daughter Jessie's experiences with numbers, etc. at home. In two cases of sharing by Jessie (aged 2 yrs., 7 mos.) of dates (to eat) with her father, she first recalls or calls up counting out dominoes, and the next day, she calls up taking turns playing with a toy with a young friend (p.50). Winter concluded that problem-solving in maths is a form of metaphoric thinking - in young children at least. That is, the problem is made sense of by substituting for it another problem selected from those previously encountered by the child, and meaningful to her / him.

Examples involving children three to five years are given in Walkerdine (1982). In one, two girls playing in the Wendy House attempt to "negotiate" a basis for playing together as follows:

> Nancy: Hello, Diane. Let's watch telly.
> Diane: I'm just tidying baby's bed up. You sit on that wooden chair. Here y'are ... Alright I'm working, I can't watch telly.
> Nancy; Mum can I watch telly mum?
>
> (Walkerdine, 1982, p.133)

First it may be noticed that the negotiation is implicit. Nancy tries to call up playing at watching television as themselves, as equals; however, Diane, while not entirely rejecting this, maintains the "television-watching" discourse but inserts herself in a position of control, as "mother". Thus the negotiation is clearly about attempting to exercise power. Walkerdine calls "television-watching" the "opening metaphor" because it has the effect of calling up for the participants the discourse for "reading" or interpreting the actions and objects of themselves and other participants. (1982, pp.133-136).

Other examples, from school, show that it is possible for pupils to become confused when there is "discursive overlap", e.g. when a task appears to be part of a "practical" discourse, yet its purpose is pedagogic. One example is given by "Keith" in the second quotation at the head of this chapter. Another instance is provided by a "shopping game", played in primary school, where a boy made "errors" in his sums. This was because he did not realise that in the game one was allowed - indeed, one was "regulated" (by the rules, made to ensure the game's pedagogic effectiveness) - to start afresh with a new 10p after each purchase (Walkerdine, 1988, Ch.7). Though the child <u>called up</u> practical shopping, through which he "made sense" of the apparent demands of the task, he nonetheless made errors because he was <u>positioned</u> in the pedagogic shopping game.

Further, we might say that this boy was positioned "inter-discursively" - in a mix or overlap of discourses - in a "shopping game" and in school maths. That is, he would be regulated by conventions of shopping - for example, that you must pay for anything "bought" - as well as by the pedagogic rules mentioned earlier. Indeed, a subject will generally be multiply positioned, in some mix of discourses (Henriques et al., 1984, p.117). - and we would expect this tendency to be even more marked with adults; some examples will be given in Ch.8, where the affective dimension will be brought in to the discussion of positioning and calling up.

(This idea of inter-discursive positioning recalls the "proportional articulation of structuring resources" in Lave (1988); see sec. 7.4.3.)

The last example also shows why the "transfer" of learning can be such a difficult problem. It is not suggested that the teacher's purpose in playing the shopping game would be to produce transferable skills (from school to shopping), nor to "harness" children's experience with shopping for pedagogic purposes - for these young children "do not really go shopping" yet (Walkerdine, 1982, p.150). But it was to give the children experience of action on money, or tokens, which could later be "dis-embedded" in the process of producing abstract mathematical knowledge. However, while some aspects of everyday shopping practice were also useful in the game - say, remembering the familiar result that "when you have 10p and buy something worth 9p, you will have 1p left", other aspects of shopping - for example, the knowledge of the requirement of giving up money to obtain a good - were not "included" in the discourse of the school shopping game. Also, importantly, the goals and purposes were quite different in the two practices. Thus, Walkerdine argues that activity within one discourse (say, playing whist) will help with school maths in those, and only those, aspects of the game which are both contained in school maths and which enter into similar relations of signification (Walkerdine, 1988, pp.115 ff.)

Walkerdine does give an example of what <u>might</u> be seen as successful transfer, though it will be noticed that it is accomplished by moving from out-of-school to school contexts - not from school to outside as is the aim of most transfer theories. The example involves what appears to be the harnessing of children's prior knowledge about counting objects etc., to lead to learning about addition in school mathematics; see Walkerdine (1988, ch.6). However, she shows how the process of "translation" / "transformation" of discourses must be accomplished through careful attention to the relating of signifiers and signifieds in particular chains of meaning. Thus,

> teachers manage in very subtle ways to move the children [...] by a process in which the metonymic form of the statement remains the same while the relations on the metaphoric axis are successfully transformed, until the children are left with a written metonymic statement, in which the same metaphors exist only by implication.
>
> (Walkerdine, 1982, pp.153-4)

To summarise, Walkerdine's work allows us to develop our ideas of cognition-in-context, or cognition-in-practice, in several ways. For her, cognition and context cannot be separated. The context of any process of social action is constituted, or "highlighted", by the practices in play. These are the practices which "position" the subjects acting, or which have been "called up" by them. These practices and the related discourses, are the basis for the subjects' <u>making sense</u> of what is happening, of formulating problems and <u>thinking</u> about them, of <u>expectations</u> e.g. as to what they ought to do. Social differences such as gender and social class are related to the positioning of a subject within a particular practice.

The fact that the particular discourse called up provides the basis for the subject's examining a problem and thinking about it, means that cognition will be <u>specific</u> to the discourse called up. (The same is true for affect, as will be argued in the next chapter.) The examples given show that the specific meanings of a word, a gesture - or any other signifier - depend on the specific discourse through which the signifier is read. The discourse(s) or language(s) in use are systems of meaning which can be analysed by considering relations of signification, and devices such as metaphor and metonymy. This brings a systematic quality to Walkerdine's discussion of language as discourse.

7.6 Summary

In this chapter, I aimed to develop a richer idea of context than is entailed in the N0 and N1 views of numeracy, to examine the related ideas about transfer of learning, and to develop an alternative view of numeracy.

The discussion here points to several aspects involved in describing the context, or activity-in-context, more fully: the goals of the activity, the language used, the social relations in the practice, and the material resources available. Though the importance of language is emphasised in all the discussions reviewed here, Valerie Walkerdine brings a much more systematic approach than the others, in her use of ideas about relations of signification, in order to analyse the ways that meaning is conveyed and interpreted. The goals of an activity are emphasised strongly by those following the "activity theorists", as a basic quality of human action; goals also can be seen to include the values of the practice, e.g. the level of precision required in calculations (Maier), and the need for "flexibility" and "efficiency" (Scribner and Lave).

Again, there is a universal emphasis on "social relations", though these are understood in several ways: Saxe emphasises "social interaction" as a resource in learning; Lave refers to "expectations" of how subjects will act in particular settings, and Walkerdine discusses the ways in which subjects are "regulated" in particular practices, thus pointing to differences in power, as well as to "social differences", related to gender and social class.

Some of the authors refer to material resources as an important part of the activity-in-context. For both Scribner and Maier, computation technology is crucial in moulding numerate thinking. A slightly different sense is implied by Lave's description of the importance of the physical layout of supermarkets (as "arenas"), or the physical characteristics of packaged foods, in explaining how subjects make decisions in shopping or dieting practices.

Saxe points to the institutional bases of a particular practice, including the artefacts involved in, say, the packaging of candy bars in a locality, and the prevailing patterns of inflation.

Finally, Saxe has produced a satisfactory account of the "activity structure" of candy-selling among adolescents in his studies in Brazil - in terms of the tasks or actions which they had to complete in a determinate cycle. Scribner attempted a similar analysis of parts of the activity of several groups of dairy employees. This is a promising additional dimension of the analysis of activity-in-context which can be tested in further research.

The views on numerate thinking discussed here can be classified into two broad approaches. The first approach, which includes the utilitarians, the ethnomathematics researchers, and in many ways also the Brazilian school, shares several important ideas. The problem or "task", and the thinking involved in performing it, are seen as able to be separated or abstracted from the context. Many tasks can then be seen as essentially mathematical, and hence it is posssible to talk about "the same mathematical task" across several different contexts. Therefore it is possible to expect that the "transfer of learning", e.g. from school to everyday situations, should be relatively unproblematical - at least, in principle.

In these views, the context of a problem can be seen to be under-emphasised, in comparison with its mathematical "essence". It is also under-specified: indeed, in much of the mathematics education literature up to the Cockcroft Report (1982) and beyond, the context of a problem was generally considered to be given by its wording. This approach allowed one to see mathematics as "practical" in the way that Cockcroft did, or to stress the importance of "functional numeracy" or N1, as discussed in Ch.2.

The second basic approach, which includes the work of those US researchers who have acknowledged the activity theorists

(Cole, Scribner, Lave, Saxe), and that of post-structuralists such as Walkerdine, diverges in several fundamental ways. Instead of seeing individual / cognition, activity / task, and context as separable, they are seen as a whole: some of this work suggests focussing on _activity-in-context_ and the _action_ / _task-in-context_ - though they also point out that it is often difficult to specify _the_ task(s) to which a subject is attending. The whole argument is that the individual (or his / her thinking) cannot be neatly separated from the context, nor can the task / activity be neatly separated from the context (with the latter as "background"). Thus this approach argues that cognition and performance are _context-specific_, in a fundamental sense.

Therefore, rather than arguing that calculating "1000 - 70" in school is "the same task mathematically" as making change for 70 cruzieros from a 1000 cruziero note in a street market, these researchers claim there is a _discontinuity_ between school maths problems, and what I have been calling numerate problems in everyday life. (This relates to my unease in Chs. 5 and 6 about whether the problems from my questionnaire which I had labelled as "practical" were anything other than "applied school maths", or in Maier's (1980) terms, "coated with a thin veneer of 'real-world' associations".) This means that previous attempts to find general solutions to the problem of the transfer of learning between contexts are undermined. (See Ch.12 for further discussion.)

Whereas the methodology used in the first approach normally involves interviews (e.g. Sewell), questionnaires (e.g. ACACE / Gallup - see Ch.2), or tests (e.g. APU), aimed at assessing the level of "performance" in (essentially) "mathematical" tasks, the second approach often uses a two-stage methodology. The first phase tends to be an ethnographic description of particular activities in context, often work practices, followed by an interview / testing phase, where somewhat unfamiliar (sometimes constructed) cognitive tasks are presented to one or several groups of subjects. In the second approach, research moves beyond the "natural" description of context, i.e. merely naming the institution where the action takes place, to describing the activity-in-context more systematically: e.g. in terms of Saxe's "parameters" (sec.7.4.4), or in terms of the discursive practices which constitute the context, as in Walkerdine and in the approach taken here.

Thus, the ideas reviewed in this chapter support a shift in my way of thinking about the practical character of numeracy. It is not a matter of defining (and finding a valid measure for) a "practical maths", as I was attempting to do in the first six chapters, nor of describing a number of different ethnomathematics. An activity cannot be prejudged as essentially "mathematics in practice", since it can be described from multiple points of view, including that of practitioners, as well as that of mathematics education researchers. What is needed is to seek to describe the numerate apects of a practice - through attention to particular signifiers in chains of meaning. This is the basis for a distinct idea of numeracy, which might be called N2, and which I shall develop in the rest of the thesis.

However, so far this new idea of numeracy has not treated affective aspects. Indeed, Walkerdine has been virtually alone among the researchers discussed here, in emphasising the importance of the relations between cognition and affect: "meanings are not just intellectual" (NOTE 24) Her ideas, and those of others on affect, will be further discussed in Ch.8.

In Ch.9, I outline the type of interview developed on the basis of ideas here (and in Ch.8), and used to study numerate problem solving in practical contexts. Walkerdine's ideas on the way the context is constituted mean that the ideas of positioning and "discursive" practice are central. Further, Walkerdine and Lave open up the possibility that a subject may be positioned in more than one discourse, in a particular situation. In studying numerate thinking during problem solving in interview, a number of issues arise:

- What are the specific discourses "available" in a particular situation?
- What determines the subject's positioning at any point?
- What indicators are there for the subject's positioning?

These issues to do with positioning and calling up will be discussed further in Chs. 8 and 10.

CHAPTER 8 : TOWARDS AN ALTERNATIVE CONCEPTION OF MATHEMATICS ANXIETY

> The desire's object is a pure, timeless unchanging discourse, where assertions proved stay proved forever (and must somehow always have been true), and where all the questions are determinate, and all the answers totally certain. In terms of the world, the desire is for a discourse that proxies the manipulation of physical reality achieving a perfect and total control of "things", where no realizable process falls outside mathematics' reach....
>
> (Rotman, 1980, p.219)

In Ch.3, I discussed research on the relationship between cognition and affect, especially anxiety; most of this work was quantitative and used self-report measures for anxiety. In this chapter, I consider the view of affect and anxiety taken in the major studies of adult cognition covered in Ch.7, and I find that strikingly little attention is paid to them; see Sec. 8.1. In Sec. 8.2, I review a selection of "qualitative" / ethnographic work (using participant observation, less structured interviews, group discussion) investigating the importance of affect, and especially anxiety, in the learning and use of mathematical and numerate thinking. I consider especially research arguing that cognition and affect should be studied as a whole. In Section 8.3, I discuss research which brings psychoanalytic insights into the discussion of affect, and in Sec. 8.4 the integration of these ideas into the post-structuralist approaches exemplified by Walkerdine's work (thereby extending the discussion in Sec. 7.5).

8.1 "Silence" about affect in studies of adult cognition

In much of the research on the use of mathematics or numeracy by adults, there is little or no explicit acknowledgement of the importance of the affective - the feelings of anxiety, frustration, pleasure, and/or satisfaction which attend the learning of mathematics and the solution of problems with a numerate component. As Nick Taylor puts it:

> Cognitive theories of learning tend to view the subject as making completely rational choices from alternatives provided by her environment; affective aspects, if taken into account at all, are considered as having a purely additive influence.
>
> (Taylor, 1989, p.162)

For example, Carraher, Carraher and Schliemann, in the only mention I could find of affect in their work (NOTE 1), play down the importance of anxiety as "some peculiarity" which is to be distinguished from "the meaning that problems have for children". Both of these points imply that the problem solver is a rather cognitive subject, and that the meaning of problems for him or her can therefore only be rather exclusively cognitive. Similarly, Lave's (1988) emphasis on goals, motivation and "value", rather than feelings and emotions, suggests that she, too, conceives of emotions in a rather cognitive way.

In one of the reports of findings from the after-school "cooking club" discussed in Ch.7, Cole and Traupmann (1979) describe a series of situations involving Archie, a child considered by his teacher to be "learning disabled". In contrast, the authors come to see Archie as constrained in the behaviours he could produce in classroom or in mental testing situations - and therefore likely often to fail -

but nevertheless as capable of exercising certain skills that were valuable for completing a task in a less constrained setting such as the cooking club.

Even in relatively more constrained settings, it sometimes happened that Archie was given a task that was "easier", or administered in less demanding conditions. One example came from a formal testing session. Archie was asked for the "similarity" between anger and joy. His initial response took 51 seconds, and he showed considerable distress. The tester too showed evidence of her distress, in the view of the authors, by deviating from procedure, first by not giving him a third member of the category (sorrow) as a prompt, and then by giving him more time and a prompt which might be considered an "instruction" to respond to the pair in a different way (Cole and Traupmann, 1979, p.29). Cole and Traupmann seem to consider that the tester may have been induced to respond to Archie "in a way that was not dictated by test procedure, ways that we think reflected her response to Archie as he, in turn, was responding to difficult problems" (pp.28-29).

A second example came during the Information Bee, a quiz involving the presentation of items from the information subtest of the WISC (an IQ test), to two teams of pupils at the cooking club. Archie showed extreme distress - bowing his head to the table, appearing to cry - as his turn on the digit-span questions arrived. Cole and Traupmann describe an atmosphere of anxiety and impending social disaster, but the clubleader administering the questions chose to give Archie a four-digit number to repeat back, rather than the seven-digit one called for by the procedures, and Archie responded successfully. Cole and Traupmann conclude, from these and other examples, that Archie "experiences difficulties when confronted with certain kinds of tasks and ... he actively organises his environment to avoid or mitigate the consequences of his difficulties" (p.32). For our purposes here, we can note that, even in the relatively constrained situations of formal testing, the subject's partners in social interaction may alter the content or the context of a problem given because of their responses within that interaction, with often predictable consequences for the "performance" displayed by the subject. Thus performance may be influenced by the affective reactions, not only of the subject, but also of other participants.

More than any of the research reviewed in Ch.7 (except for Walkerdine's), Cole and Traupmann's appears to engage with affect. Yet, here too, there is a very cognitive flavour to the discussion: the emotional distress evinced by Archie, and the supposedly related distress produced in the tester and in his fellow students, are seen as simply part of the set of outcomes of this action in context, rather than as having a clear emotional quality. In addition, there is no description of the process whereby the distress of the tester, for example, is a response to Archie's. Thus, the Cole and Traupmann article is typical of the US work based on activity theory (see Sec. 7.4) in its focussing on actions with a predominantly cognitive lens.

This is somewhat surprising, given an earlier article (Scribner and Cole, 1973) arguing the need for studies of "informal learning" like those described in Ch.7. They noted that informal education tends to fuse the intellectual and the emotional: because of the high "affective charge ... associated with almost everything that is learned within that context.... the content of learning, especially for children, is often inseparable from the identity of their teacher" (p.555). (NOTE 1a)

Further, D'Andrade (1981), cited approvingly by Lave, argues for the inseparability of the intellectual and the affective - both on the cultural grounds given by Scribner and Cole, and on the grounds of what might be termed the indivisibility of meaning. For example, the sentences "the stove is hot", and "Joe is a cheat" convey both ideational and affective meaning: the latter encodes not only a representation of the speaker's feelings, but also directs how the listener should act by virtue of an assumption of intersubjectivity. Thus, the distinction affective versus ideational is analytic only. Again, the strength and effectiveness of the affective component of "cultural representations" like the above is due to its being communicated "through face and voice by the important people in one's life" (p.193). Yet, even when we come to the more recent discussions of "situated cognition" as compared with school learning, e.g. Resnick (1987) and Brown et al.(1989), we again find the familiar void concerning the affective.

This brief discussion illustrates the surprisingly low level of attention given to the affective in the discussions of adult cognition reviewed earlier.

8.2 Recent Conceptions of Affect and Anxiety in Mathematics

Three main studies by Sheila Tobias (1978), Ginsburg and Asmussen (1988) and Laurie Buxton (1981, 1991) are discussed in APPENDICES X1, X2 and X3, respectively. They provide a rich description of affect, and especially mathematics anxiety (NOTE 3), using interview and (in Buxton's work) group discussion material. All three studies have also emphasised the centrality of affect in the understanding of mathematical learning and performance.

Yet there are theoretical differences. Tobias seems to see maths anxiety as being external to, and having a causal effect on, performance and perseverance in taking maths courses (cf. the discussion of "differential" models in Sec. 3.1). Ginsburg and Asmussen take an intermediate position, describing anxiety both as influencing learning (and in turn being influenced by it), but also as seeming to be part of cognitive activity: "mathematical thinking is clearly 'hot'" (1988, p.107). Buxton considers emotion to be what "powers" cognition, and therefore to be inseparable from it.

Both Tobias and Ginsburg and Asmussen seem to accept the idea of levels of maths anxiety, in that she quotes results based on maths anxiety scales (e.g. Betz, 1978, using the Fennema-Sherman MAS scale), and they use the MARS. Buxton, on the other hand, is content to let his subjects describe their negative experiences largely in their own terms. Here the use of group discussion is valuable in allowing the members compare experiences, and terms used to describe them.

Overall, these studies suggest that the use of interviews in research with adults may help to produce a fuller description of thinking and emotional experiences in problem-solving situations. Buxton's work also points to the need to engage with psychoanalytic ideas.

8.3 Insights from Psychoanalysis

8.3.1 Theoretical basics: Freud and Lacan

Freud's views on anxiety were introduced in Sec. 3.2. To recap, he characterised anxiety as unpleasant feelings linked with motor discharges which were "perceived" by the subject. There is a tendency for anxiety, or for the ideas associated with it, to be pushed into the unconscious, through the operation of repression, one of the defense mechanisms: "defence can be directed not only against instinctual claims, but also against everything which is liable to give rise to anxiety: emotions, situations, superego demands, etc." (Laplanche and Pontalis, 1973, p.110). If repressed contents "returned" to consciousness, they would retain their charge but would tend to be found in a disguised or distorted form - for example, as jokes, or "slips of the tongue", or in dreams. Since in the psychoanalytic view, anxiety may be unconscious (or linked with ideas which are unconscious), it cannot be assumed to be observable in any straightforward way - let alone, susceptible to self-report. Because of defences, anxiety may appear in distorted form: as "no feeling at all" - or indeed as the opposite of anxiety, e.g. over-confidence. What may also be distorted is the focus or the object of the anxiety. For example, in agoraphobia, the fear of the feelings one may have in a crowd is displaced (see below) into an apparent fear of the street. It might be reasonable to expect a similar displacement in a mathematics phobia.

In his later work (1926/1979, 1933/1973), Freud made a distinction between anxiety as an automatic reaction to trauma - of which the prototype is the birth trauma, and anxiety as a warning of the approach of such trauma. Examples of the latter, and therefore possible focuses of anxiety are:

- loss of the mother as object;
- loss of the object's love;
- loss of the penis; and
- loss of the superego's love (i.e. guilt).

Freud and his successors enumerated a number of defence mechanisms, including: repression, regression, projection, sublimation, "reversal into the opposite"; these might use a range of processes from fantasy to intellectualisation (Laplanche and Pontalis, 1973, pp.103-111). Melanie Klein extended the work of Freud in her account of defences in pre-Oedipal children, especially "splitting of the object", projection (NOTE 9), the "manic defence". Splitting occurs, for example, when the mother is absent: the child does not just produce a positive fantasy of the mother - but also "splits" the mother (or the breast) into a "good" and a "bad" part. Thus the child can want both to have the breast, and to destroy the breast. The manic defence is directed against the experience of dependence (on the mother) and the fear of loss (Gottheil, n.d., pp.10-11); it is characterised by feelings of "control, triumph and contempt". (For further details on Kleinian ideas, see e.g. Hinshelwood (1991).)

The work of Jacques Lacan is relevant in a number of ways, summarised here (see e.g. Henriques et al., 1984, pp. 212 ff. and Urwin, 1984). First, Lacan used a theory of signification in the form of structural linguistics (see Sec. 7.5) to establish links between words and ideas (see below), whereas Freud's more mechanical approach referred to "memory traces", associations, etc. Lacan thus allowed a space for the social, by giving priority to the "symbolic order", or language, which predates the infant's birth, and into which (s)he must enter in order to become an effective, fully conscious member of the community - "within the terms set by pre-existing social relations and cultural laws" (Henriques et al., p.213).

In Lacan's work, "desire" permeates the working of language. Unlike a "need" which for can be met in principle, desire (NOTE 4), because of the fundamental "loss" involved in its production, is not able to be totally satisfied, and has to be fulfilled by a fantasy or dream:

> Like Freud, Lacan regards the mother as providing the infant with his or her first experience of satisfaction. But the infant must come to terms with the loss of satisfaction, or the absence of its source, the mother. In Lacan's account, the child uses his or her first words to establish, in fantasy, control over the loss of the object which first gave satisfaction. As words displace the original object, we see the first step in the process of repression which forms the unconscious; entry into language inaugurates the production of subjectivity....
>
> (Henriques et al., 1984, p.215)

Thus the entry into language is the precondition for subjectivity. It is also the first step in forming the unconscious, through repression, as words displace the object which is "lost".

Anxiety is created by the absence of satisfaction itself, or by the fear of loss of the source of satisfaction. For Lacan, like Freud, the attempt to master this anxiety and ultimately to control desire is the impetus to acquire language. In entering into language, the child's own thought is inevitably regulated through cultural laws; for the male child, the child's desire for the mother has already become the desire of another - the father - with whom he is now in competition, because of having entered into the same frame of reference (Urwin, 1984, p.278). It is only through resolution of the Oedipus Complex by identifying with the same-sexed parent, that the child is able to communicate on the same terms as adults - to take alternative positions, by appropriate use of personal pronouns ("I" / "You"), and to become aware of him/herself as a distinct entity.

For Freud, repression was turning something away, and keeping it at a distance, from the conscious. Repressed material is to be contrasted with ideas and memories which are "forgotten" in the preconscious, but which can be made conscious relatively easily. It is repulsed by the preconscious, and attracted by a (repressed) chain already existing in the unconscious. For Lacan, this may be seen as a chain of signification, rather than as simply a chain of associations. (NOTE 3a)

Lacan's assertion that the social, namely the signifying order, enters into the formation of the unconscious, leads to the idea that the unconscious is "structured like a language" (Thom, 1981; Henriques et al., 1984, p.213). He inverts de Saussure's idea of the relation between the signifier and the signified as for example on the left-hand side of Fig. 8.1 - for several reasons. First, the signified becomes less and less important, as it is always receding, eluding us. Meaning therefore springs from metonymic and metaphoric relations between signifiers. Also, Lacan sees repression as metaphor, that is as the process of a new signifier, S', replacing the original signifier, S, which now "falls to the level of the signified"; see Fig. 8.1.

Fig. 8.1 Lacan's View of Repression: the Signifier Falling to the Level of the Signified

$$\frac{\text{signifier S}}{\text{signified s}} \longrightarrow \frac{\text{new signifier S'}}{\text{original signifier S}}$$

Lacan argued that there were "homologous" relationships between the semiotic processes of metaphor and metonymy (described in Sec. 7.5), and the two key operations of "dream-work" (NOTE 4a), condensation and displacement, respectively (Thom, 1981). Condensation occurs when there are connections between one signifier in the manifest content, and multiple elements in the latent dream-thought; we might say that meaning is "condensed" on the single signifier in the manifest content. Displacement was for Freud a process by which energy is channelled from one object to another object; in dream analysis, it appears as a form of "distortion", in that elements that are central to the manifest content may be peripheral to the latent dream-thoughts, and vice-versa. This distortion is made necessary by the existence of "censorship" between the conscious (and preconscious) on the one hand, and the unconscious, on the other. Thus the operation of metaphor and metonymy are interdependent: metaphor creates a superimposition of signifiers; metonymy effects a continual sliding of signifiers. For further discussion and an illustration (NOTE 5), see Martin Thom's (1981) "reading of Freud through Lacanian spectacles".

This not the place for a full evaluation of Lacan's contribution to the study of affect and subjectivity. The emphasis on signification in his work seems to make a valuable contribution to elucidating how unconscious processes might work, and in particular how the social is implicated in these. However, Lacan's emphasis on a universal and timeless symbolic order seems to limit the extent to which the influence of the social can be specific to a given culture and period. Further, it is not yet clear how his approach can provide an explanation of differences in subjectivity between subjects in the same historical and cultural location.

An attempt will be made to extend the analysis in the next section, when the contribution of several "post-structuralist" researchers will be considered. However, first I consider two studies of mathematics affect done within a psychoanalytic perspective.

8.3.2 Empirical studies done within a psychoanalytic perspective

Nimier (1978) reports on a study which used both clinical and statistical methods. He began with interviews with about 60 subjects, starting off from three questions about:

- progress in mathematical studies;
- feelings while doing mathematics; and
- whether they had discussed maths with parents.

He then developed questionnaires including semantic differential, "closed" (Likert-type), and verb-choice items, based on the themes arising in the interviews, and addressed to n=600 subjects. The subjects were students in final year lyceé, including male and female, humanities and science specialists.

In the interviews, Nimier found a certain amount of anxiety ("angoisse") about mathematics. This took different forms:

- anxiety about the loss of one's own personality;
- anxiety about destruction;
- anxiety about separation / solitude; and
- anxiety about castration (pp.168-170).

These anxieties may of course be displaced ["déplacé"] - but they may be recovered by: (i) associative chains produced spontaneously by the interviewee; or (ii) the "slipping of meaning" through a signifier. As an example of an associative chain, he offers the following (where R = researcher and S = subject):

> S: Right from the start I set myself against learning algebra... Why algebra? I've been asking myself that question [for three years]. [...] the teacher [..] that poor woman had a voice to put one to sleep. [...]
> R: A voice... a voice that reminded you of what?
> S: What did that remind me of? Yes, definitely, it must have recalled something [..] particularly disagreeable certainly... [..] something or someone that struck me or displeased me....

R: Someone?

S: [..] It was like a _purring_. [..] very soft. Oh, I think it was in connection with something else, but I don't want to tell myself that it's possible that it was that...

R: What are you thinking of? Even if it's not that, it doesn't matter...

S: All right! Because there was [..] a very big disagreement between my mother and father [...] all these nights, I didn't sleep because I heard the arguments [..] in a half-_sleep_ and each time I arrived in maths class I heard that _voice_ [...] that made about the same noise, the same _purring_. So that got on my nerves....

(Nimier, p.169; author's emphasis; my translation)

Here we see that the student's experiences in the algebra classroom are associated with those from a time when she was trying to sleep next to where her parents were arguing. The link is through the "purring" sounds of the voice(s) (the signifiers) that were features of both situations; the "disagreeable" affective charge has been _displaced_ from the memory of the bedroom / pillow / going to sleep situation to the current experience of the algebra classroom, which "gets on [her] nerves" and against which she "set [her]self". We can again see the process of the original signifier, the parents' voices (linked with parental strife as signified), dropping to the level of the signified, where the purring voice of the teacher becomes the new signifier. Thus this interview analysis illustrates the ideas of condensation / metaphor and especially displacement / metonymy discussed by Thom (1981) in the previous section. (NOTE 6)

As an example of the "slipping of meaning through a signifier":

R: What does mathematics bring to you?

S: I think it's above all the rigour which is important in that. Mathematical rigour is something fundamental.

R: Yes. Why?

S: [..] There is a solution: it's that or it isn't that. [...] In mathematics it's something pure [...] And rigour, I've always liked rigour: when I was little, I recall, I asked to be whipped ["fouetté"].

(Nimier, 1978, p.169; my translation)

Here the signifier "rigour" allows the subject to effect a sliding from the sense of moral demands to mathematical demands. This illustrates another form of displacement (Nimier, p.169). (NOTE 6a)

Nimier offers a typology of <u>defences</u> against anxiety around mathematics. Category A seeks protection <u>against</u> mathematics as a dangerous object; category B seeks protection <u>by</u> mathematics as a good object. Category A defences may be divided into:

(A1) avoidance;

(A2) denial of reality; e.g. claiming mathematics is meaningless; or

(A3) attempts at omniscience, or mastery.

Of course, the "danger" of mathematics may simply be a projection of the subject's own nastiness or destructiveness.

Category B defences (seeking protection <u>by</u> mathematics as a good object) may be divided into:

(B1) a "reparative" defence (against destruction anxiety) where mathematics is felt as useful, constructive, an object of value;

(B2) a manic ["maniaque"] defence (against depression provoked by separation / solitude anxiety) which aims for (the fantasy of) omnipotent control.

Nimier notes that with this latter defence there may also be found a "splitting ["clivage"] of the object" (mathematics) into "bad" and "good"; see the brief discussion of defences in Kleinian theories at the beginning of this section, and also Hinshelwood (1991).

Defences A1 and A2 are likely to be used by Humanities students, and are likely not to be favourable to success in mathematics. On the other hand, A3, B1 and B2 are likely to be used by Science students, and are likely to be favourable to success in mathematics.

To sum up, Nimier's work shows the importance of the defences against anxiety, and the operation of unconscious processes such as displacement in the appropriation of knowledge, especially mathematical knowledge. It is important not to separate knowledge and affect: the first object of knowledge for the child, the mother, is also the first love-object; and in the Bible, to "know" someone is to make love with them (p. 172). (NOTE 6b)

Legault (1987) also attempted to study the cognitive and the affective together, by using Piagetian tests and projective tests (Rorschach and TAT; see sec. 3.2.2). Here she studied girls only, aged 11-12, one group (n=10) that was good in maths and one group (n=10) that had specific difficulties.

Her findings confirmed Mathematics as a site of anxiety: both groups perceived it as a "set of laws having irreducible demands", which generated fear, whereas French as a subject left more space to the imagination and to creativity (p.123). There also appeared to be a relation between an active "seeking of the father" and success in maths, on the one hand, and disappointing relations with the father (plus a refusal to please or to obey the mother) and failure in maths, on the other. (NOTE 7) In the interviews, subjects strong in maths mentioned the support of their families, whereas weak subjects made no reference to their families, but only mentioned their own difficulties, e.g. with concentration. (NOTE 7a)

Legault drew two very important conclusions. First, success or failure is inscribed in a whole dynamic particular to each student. Therefore, it is not possible to tie success or failure in a general fashion to a specific affective factor (p.123). This suggests, among other things, that in the analysis of my interviews, it is important to focus on the whole range of affective factors, and not just anxiety.

Second, in order to understand anxiety, it is necessary to look for evidence of defenses, rather than attempting to measure the level of anxiety itself. This helps to make possible empirical work in this area, in the light of the Freudian view that anxiety may often not be observable (see above). Thus, the problem would become one of attempting to find sayings, gestures, etc. that might indicate the operation of defenses against anxiety; e.g. making jokes or "slips", speaking or behaving in a manner that is not customary (for that person), and so on (see sec. 9.2.4).

8.4 Insights from Post-structuralism

8.4.1 Valerie Walkerdine

Walkerdine's work has already been introduced in Ch. 7. It was based theoretically on the ideas that thinking, learning and performance are specific to a context, which is "constituted" by one or more practices. These practices position the person in discourse, in a way that depends on social differences such as gender and social class.

As signposted in that discussion, the cognitive and the affective are viewed in Walkerdine's work as inseparable aspects of the same ensemble of meanings acquired through learning - since learning takes place within discursive practices, and these are emotionally charged (see also Scribner and Cole (1973) and D'Andrade (1981), discussed in Sec. 8.1 above). This intertwining is illustrated by the following:

> Mathematical meanings - indeed, the development of language and word meanings in general - cannot be separated from the practices in which the girls grow up. The mother is positioned as regulative in these practices, in which desires, fears, and fantasies are deeply involved. So "mathematical meanings" are not simply intellectual, nor are they comprehensible

> outside the practices of their production.
> [...]
> at home [...] these terms [..] carry strong emotional [..] content and act as signifiers in very different [ways] from the word pair "more" / "less" as used in school mathematics....
> (Walkerdine and Girls and Maths Unit, 1989, pp. 52-53)

Thus, what might be seen as "mathematical meanings" are both cognitive and affective, and they depend on the child's positioning in specific social practices, some of which may be sited solely (or largely) in the home, with others sited in the school. However, the affective qualities of these meanings cannot be read off simply from the site (or from the name) of the particular practice (NOTE 8). For example, Josette Adda, in a passage criticising the artificiality of many word problems in school maths, points to the unpredictability of the relationship of the direction of the affective charge (i.e. positive or negative) with other key features - in particular, the intensity of the affect, or the familiarity of the site :

> [For] problems of the type "Mummy goes shopping, she buys ..." [...] this variable "Mummy" (each pupil supposedly feeling involved) introduces an emotional factor that is not necessarily positive: for example, when the mother has financial difficulties, has little time to do the shopping, is sick, far away or deceased....
>
> (Adda, 1986, p.59)

This suggests that the affective meanings cannot be read off from the site in any simple way such as:
home, out of school, etc. ... familiar ... "positive"; and
school, mathematics, etc. ... unfamiliar ... "negative".
Other examples of the unpredictability of the relationship between site and affect will be given in the analysis of the interview case studies; see Ch.11.

It is further to be expected that the affective response to "the same" site may be different for different subjects (see below). Yet it is not sufficient to reduce the affective meanings of mathematics to its being a "good" or a "bad" (or "protective" vs. "threatening") object for that subject - even if "splitting" is allowed for - as Nimier seems to do, in his classification of defences (NOTE 6b). In order to more fully appreciate the particularity of each subject's feelings towards "mathematics", we need to consider the specific discourses in which the subject has been positioned.

As has been argued in Ch.7, these positions, and the thinking and affect produced within them, are made possible by, and hence are specific to, specific practices. In the case of school mathematics discourses, it was argued that many of the main terms are understood as "gendered", rather than gender-neutral. For example, active learning, rule-breaking, naughtiness, aggressiveness and (potential) rationality tend to be seen as "masculine", while passivity, rule-following, helpfulness, nurturing and emotionality tend to be linked with "femininity".

In her later work, Walkerdine (e.g. 1985, 1988) seeks to provide an explanation as to why these links have been so persistently made, and confirmed, and reconfirmed. Her argument has several parts. First, she argues historically that the development of science and mathematics from the 17th century has been closely connected to the control of nature by man, and that since this time, "reason has been a capacity invested within the body, and later the mind, of the man, from which the female was, by definition, excluded". Women were excluded - for example, from higher education and the professions in the 19th century - on the grounds that they were swayed by their emotions, and not, therefore, invested with the capacity to make rational judgements (Walkerdine, 1985, pp.6-7). Thus we can say that rationality and mathematical understanding are gendered. And these days the "lack" on the part of women in terms of mathematical understanding, etc. is open to study and measurement by the sciences of psychology and education, and relevant evidence can be produced, examples of which were discussed in Sec. 2.3; see also Lee (1992).

The second part of the argument suggests deep-seated emotional reasons, at the level of cultural groups, for what Walkerdine sees as the tenacity of these ideas. She suggests parallels with Homi Bhabha's (1983) discussion of the "fear of the Other" inscribed in the stereotypes of the colonised people that form part of the coloniser's discourse. Much of the material of such views is argued to be fantasy, based on the projection of characteristics feared or disapproved in oneself onto "the Other"; e.g. laziness, dishonesty, excessive sexuality, etc. (NOTES 9, 10); these processes of fantasy and projection will involve the unconscious. In the case of gender relations and stereotypes, following the argument above that rationality and mathematical understanding are gendered, the unconscious fear of irrationality may lead to its being projected onto the woman. Further, "the Other of mathematics is uncertainty, irrationality, out of control...." (Walkerdine, 1988, p.199).

The third part of the argument considers what might be the emotional "investments" in involvement in mathematics at the level of the individual subject. "Reason's dream", as described in the quotation at the beginning of this chapter (Rotman, 1980), is sought and embraced by some, generally boys. ("Reason's dream" may also be sought by girls, but to the extent that reason and mathematics are made to signify in a gendered way, the girl cannot "have it".) (NOTE 10a) The dream is of an all-comprehending, unchanging, infallible discourse, based on an omnipotent fantasy of mastery through the use of intellectual reason over a universe which is thereby ordered and controllable (Walkerdine, 1985, 1988; Rotman, 1980). Walkerdine (1988, Ch.9) traces the basis of the dream of control to the apparently universal applicability of mathematics, which flows from its seeming "decontextualisation".

These features, however, mean that the learner has to "suppress" the metaphoric content of the statements made in mathematics to leave simply a metonymic string - though the signifiers within it remain linked by chains of signification to other discourses. Nevertheless, these links including those to aspects of value, emotionality and desire, need to be "forgotten" by the successful learner of mathematics. This forgetting may involve repression, which then needs to be coped with by "wish-fulfilment" through processes produced by the unconscious such as dreams and fantasies (see the previous section and Walkerdine, 1988, pp.183-191). (NOTE 11) Thus "Reason's dream" and the mastery of mathematics in particular provide one way for a fantasy of omnipotence and control to be "lived". (Whether this way is taken up by a particular subject will depend on a particular subject's "investments"; see the discussion of Hollway's work below).

At this point, we can note that the three parts of Walkerdine's account of why women have been so persistently considered as unsuited to reason and to mathematics, depend on different types of evidence. The first involves showing that particular sets of ideas, including those of the gendering of reason and mathematical thought, were important, indeed hegemonic, in particular historical periods. Walkerdine herself attests to the challenge of such a task in a related context: it would require using primary sources to examine "who supported and opposed what educational and psychological moves and in what terms" and "a conjunctural analysis of the balance of social forces" (Walkerdine, 1984, n.20, p.200).

This sort of evidence is not available in the account of the first part of Walkerdine's argument, though her conclusions seem plausible and consistent with other writers, including those using primary historical sources (e.g. Clements, 1979). In addition, her own research in schools (Walden and Walkerdine, 1982, 1985; Walkerdine et al., 1989), using participant observation and interviews with teachers, provides evidence that these sorts of views were subscribed to by the teachers in those schools (see Sec. 7.5).

The second part of the argument appears to be even more difficult to assess, since it seems to require judging the presence of certain types of collective anxieties or fears in particular cultural practices. However, such discourses generally produce texts (e.g. Colonial Office manuals, orientation programmes for new officials) which can be read. Further, some support for the idea of collective defences against anxiety is provided by Ellen Gottheil (n.d.). She reconsiders the sort of evidence on gender differences in maths performance and maths anxiety produced by "the sciences of psychology and education", and referred to by Walkerdine as providing the basis for the "expected", the "normal". (Some of this evidence is discussed in Chs. 2 and 3 of this thesis).

Gottheil takes as an illustration a large study of men and women post-graduates in science, engineering and medicine at Stanford (Zappert and Stansbury, 1984; see also Becker, 1990). The results showed no gender differences in ability or undergraduate performance, but women assessed themselves as less competent in maths and sciences, and reported greater anxiety and stress-related symptoms; finally, both genders expected men to outperform women in mathematics. Given that the study sample was just the sort of group where the "truth" of such expectations should be most in doubt, Gottheil argues that these students were exhibiting defences of denial, repression, and rationalisation (p.5). And why?

For Gottheil, the link between gender and maths is related to the attempts at the level of the culture to confront and defend against the most basic anxieties. Since she is also working within a Kleinian perspective, she refers to a set of "primal" anxieties, similar to Nimier's (see previous section):

- anxiety about the destruction of self, or ego, or personality;
- anxiety about the loss of the loved object (mother); and
- anxiety about dependency and helplessness.

Gottheil draws support (p.6) for the idea of collective defences against anxiety from Eliot Jaques' studies of organisations (e.g. 1977); see also Isabel Menzies (1960). For example, the primitive Kleinian defences of splitting and projection may combine to produce rigidly differentiated gender characterisations, e.g. active vs. passive, rational vs. emotional, etc. - just as in the gender stereotypes discussed earlier. And splitting, along with the manic defence against helplessness and dependence, may provide boys and men with payoffs resulting from the derogation of the woman as passive, "merely" emotional, etc., and from fantasies of control (pp.11-14). Again, these arguments about the bases of gender stereotypes, like Bhaba's (above) about colonial discourses, are certainly plausible; however, these issues, and the second part of Walkerdine's argument, cannot be discussed further here.

The third part of the argument, which describes one way for a fantasy of omnipotence and control to be "lived", could be assessed by the analysis of the sort of interview material presented by Nimier and Legault in the previous section. (NOTE 11a) Of course it would be necessary to describe and investigate the possible existence of other possible sets of affective dynamics vis-a-vis mathematics. Indeed, two sorts of pleasure, relating to two very different positions in relation to mathematics are described by Walkerdine (e.g. 1988, pp.194ff.) On the one hand, Michael and Tony, two pupils working on place value in the "faster" group in a particular classroom, derived pleasure from the apparent power of the methods they were using. In their learning of the discourse of mathematics, these boys were also enjoying the fantasy of mastery and control (Walkerdine, 1988, Ch.8 and p.199).

On the other hand, in the "shopping game" played in the same classroom (already discussed in sec. 7.5.1), most of the pupils (several girls and one boy) seemed to call up a practice of shopping in which they were positioned as unaccustomedly powerful customers: they had continually renewed resources (10p), and paid unrealistically low prices (e.g. 2p for a yacht). This allowed them to derive a great deal of pleasure from the fantasies invested in their positions. (NOTES 12, 12a) But it was not clear how much mathematics they learned, because of their involvement in the fantasies - which they did not "suppress" (see above), but which provided the basis for their enjoyment. Walkerdine suggests therefore that this group's pleasure was double-edged, a double-bind: "While they fantasise about being rich, they cannot 'master' subtraction" (p.198). Further,

> Their inscription as subjects within everyday practices is [..] cross-cut, in the very relations of signification themselves, by desire. Absence, lack, loss, prohibition are present. And the subject's experience [..] therefore of the practices in which 'numeracy' is produced, must be relations of desire. They are not formal systems, but lived relations of power and powerlessness, of wanting, having, being; they are continually open and shifting, not closed axiomatic systems like mathematics.
>
> (Walkerdine, 1988, p.198)

The discussion of different types of pleasure suggests that there are not just two, but a proliferation of, possible sets of affective meanings related to everyday practices - and hence to their numerate aspects. It is not the case that these numerate aspects "are" mathematics, but they may be taken to signify mathematics (Dowling, 1991). And as Walkerdine argues above, their metaphorical and affective associations may be suppressed, in an attempt to produce mathematics. These affective meanings will depend on the particular subject's biography - in the sense of their history of positionings - within these discourses. (This latter idea is in line with the arguments of Legault that success or failure in mathematics is inscribed in a whole dynamic which is particular to each student; see the previous section).

Further, as the quotation from Walkerdine suggests, in order more fully to appreciate the particularity of each subject's affect towards "mathematics", we need to understand its production within a positioning (a sometimes contradictory one) within a web of interlinked discursive practices (Henriques et al., 1984, pp.218-226). Though we can build on the emphasis on signification in the work of Lacan (among others), we also need to take the analysis beyond his idea of a universal and timeless social order and to take account of the historically specific quality of discourse. (NOTES 13, 13a)

So far, we have the basis of an argument as to why it should be more "expected", more "normal" - in general and in UK schools in particular (see the account of Walkerdine's school research in Sec. 7.5 and above) - for girls to perform less well, or at least in a way lacking in "flair", and for boys, at least some, to excel. Put another way, we can see how girls' "failure" in maths is socially produced, in (discursive) practice. But it is still not clear why girls should be any more anxious about this "normal" state of affairs, or about mathematics - if indeed they are!

Ellen Gottheil reminds us that anxiety for Freud was a signal of unconscious intrapsychic conflict that leads to the mobilisation of defences. She therefore argues that maths anxiety is such an indicator of intrapsychic conflict for some women - especially "high performers" in maths. This argument is supportive of that made about the "fear of success" by Horner (1968, 1972); see sec. 3.2.4.

Concerning social class differences in anxiety, the above arguments suggest that it may be more difficult to mathematise, or to intellectualise, a problem - i.e. to "suppress" the metaphoric links in the discourse called up to solve it, if there is much anxiety around it. Thus to the extent that contexts involving money, and consumption generally, have involved the pain of deprivation and increased or stricter regulation, there will be a tendency to fantasise about wish-fulfilment, rather than to go for mastery; again, the children playing the shopping game at school provide an example. Of course, middle class children may be anxious about other matters, e.g. poor performance academically.

8.4.2 Affect and Desire as Particular: Nick Taylor and Wendy Hollway

Nick Taylor's research (1989, 1990a, 1990b) was conducted with a class (n=34) of black 13-year-olds in Soweto, South Africa in 1984-88. They were given test questions, both before and after being exposed to educational television programmes aimed at aiding maths learning. Both pre- and post-tests included a question about the fraction of a whole to be shared out evenly among 5 or 6 children; the former was couched in terms of cutting a loaf of bread and the latter was about cutting a cake.

Taylor's argument follows the same sort of path as have the last two chapters. He began his work with the "undeconstructed cognitivist notion that the situational referent of a party and the cake would somehow provide the handle for better understanding the mathematical ideas, without examining the specificity of such referents" (1990a, p.280). The "handle" presumably involved the greater _familiarity_ of the party / cake context (compared with an abstract one), or perhaps its more _positive_ affective charge.

In addition to giving the pupils problems to try in a test, Taylor conducted a series of three or four interviews each with four of the pupils, where he gave them the same problems to try. He also sought to elicit other associations, e.g. by asking who cut the bread and the cake in various contexts. In the interviews with Paul, Taylor found that he dealt with the sharing of a loaf of bread among five children by visualising the slicing of the loaf into ten slices, and then giving each child "two-tenths". In contrast, to share a cake amongst six children, Paul proposed the formal solution of one-sixth. Taylor argues that the difference in strategy used in the two contexts shows that mathematical activity is not merely "rational but is somehow tied in to profound emotional and/or cultural forces." (1989, p. 162)

However, these forces are clearly not <u>only</u> cultural or social, since Taylor observed differences in approach to the two questions among children from the same cultural milieu. For the bread problem, about half of the students in the class appeared to call up "culturally embodied" practices involving bread, the other half calling up an "abstract" discourse, school maths. For the cake problem, only about one-third of the students appeared to call up a culturally embodied response (1990a, pp. 267-270).

Taylor sees the bread and the cake as different "metaphors" for the same "metonymic" principle, that 1 divided by n = 1/n . He argues that the different metaphors tend to call up different discursive practices, with associated positions, for each particular subject. The subject-position in turn is instrumental in determining the kind of strategy adopted in making sense of the problem (1990a, pp.277-8). For example, for Paul, the "bread metaphor" tends to call up contexts such as "lunch with grandmother" - which allows the use of <u>familiar</u> methods of thinking (and hence calculation) grounded in the procedures of slicing a loaf. For Paul (and similarly for another young male, Camel) bread is also associated in <u>positive affective</u> terms with his participation in sport and with the care of his body - based both on science teaching at school, and also on lifelong memories: when asked why he likes bread more than cake, Paul replies:

> Because, meneer [sir], I have liked bread since I was young. (Taylor, 1990a, p.259)

Taylor sees the effect of all these associations as follows:

> Bread is part of the web of his life. It nourishes him and provides energy for feats of physical prowess. It is associated with the routine lunch provided by his

> grandmother. Bread as signified and signifier is tied to earliest memory and thus [..] closely linked to originary loss and the primal phase of signification. It is at this juncture that the subject, through the production of word signifiers, attempts to satisfy the unfulfillable desire and to exert fantasy control over the lost world. The bread metaphor calls up a process embedded in everyday practices: [Paul] moves with great assurance toward the identical argument [..] on each of two occasions separated by seven months.
>
> (Taylor, 1990a, p.260)

On the other hand, cake is seen as sweet and unhealthy, a signifier of birthday parties. Thus the cake metaphor is less familiar, and less positive in affective terms. Here, Paul and Camel apparently need to "fall back on" algorithms, which, being less familiar, tend in Paul's case to decay into forgetfulness and "garbled numerese" (p.259).

Taylor is arguing that "bread" is a <u>key signifier</u> in the life of Paul (and Camel), and that it is implicated in <u>wish-fulfilment</u>, through processes in the unconscious attempting to satisfy (unfulfillable) desire. These processes use condensation and displacement: on the analysis above, we can note the condensation of multiple meanings on the signifier "bread", and it is reasonable to make a tentative interpretation (using available evidence) that desire will have been displaced from the satisfactions of eating with the mother, parents, or grandparents, to bread.

Therefore, he argues that any attempt to understand the pupils' thinking about these apparently "mathematical" problems in terms of cognitive and cultural processes only, will be unsettled because the thinking is also infused, charged, invested with affect - which he sees as relating to unconscious desire and wish-fulfilment. Wish-fulfilment is a seen as a "primary element in orienting any individual toward a particular subject-position" (p.278) - or, we might say, toward "calling up" a particular practice (echoing our discussion in Ch.7).

In evaluating Taylor's work, we must sound a note of caution about the data and its interpretation. First, any conclusions based on two boys may be representative - or they may be atypical. Also, even a series of three or four semi-structured interviews per child is of limited depth for producing the sort of psychoanalytic interpretation offered here. These interpretations are fascinating and plausible - and very tentative!

Next, we must consider how Taylor deals with the idea (considered problematical by Adda in the previous subsection) that posing problems in the generally familiar contexts of, say, "mother", or "bread", will be more positive in affective terms and thus presumably facilitate problem-solving. He avoids seeing affect as a general "add-on" by considering the specificity of different practices, such as those in which "bread" and "cake" respectively are central terms. At the same time, he emphasises the particularity of the meanings within these for each subject. As for what facilitates problem-solving, Taylor explains as follows: the "roles, rules and procedures within the 'bread' practice are clearer to [Paul] than those of the 'cake' discourse" (p.257; emphasis added). This suggests that the important aspects of difference between the practices are to do with familiarity and the role of memory.

There also appears to be some contradiction between Taylor's finding that calling up a bread-related discourse which is familiar, and in which desire might arguably be implicated, seems to help problem-solving, and Walkerdine's view that the children's insertion in fantasy-charged positions in a shopping "game" at school led to the children's making errors (procedural, at least), and, she claims, interfered greatly with their learning maths. However, we can see that the two groups of pupils were positioned quite differently: Taylor's were in a one-to-one interview situation, where they had to perform and where they could "harness" previous learning in everyday practices - whereas Walkerdine's were in a differently regulated group learning situation which required them to suppress many of the aspects of the everyday (shopping) practice called up, if they were to be able to enter the school mathematics discourse.

Taylor's work makes several contributions to my project here. He uses interviews to elucidate the relationship of the "metaphoric content" of the problem with the discourse (and related subject-position) called up, and hence with the strategy deployed to produce a response. In the examples given, this is based on a distinction between an "embodied" response from within an everyday practice or an "abstract" response based on school maths. This process of calling up depends both on cultural / social factors (e.g. the existence of bread and birthday parties, family formations and child-rearing practices, etc., etc.) and on emotional processes which he argues have an unconscious aspect. (NOTE 14).

Wendy Hollway (1984, 1989) makes related points concerning the development and character of subjectivity. (NOTE 14a) She sees subjectivity as the product of the person's "history" (i.e. biography) of positioning in discourses, and of the way this constructs their "investments" in taking up gender-differentiated positions - thereby re-producing the discourses. It can be seen that this work shares with Taylor the concern of allowing for "particularity" in the explanation of thought and feeling, and differs somewhat from those writers like Foucault and Lacan who emphasise the prior existence of discursive practices or the signifying order.

Hollway (1984, pp.230 ff.) begins with the idea that discourses are historically specific, and they "make available" subject-positions for subjects to take up (a less determinist position than Foucault). She considers several discourses concerning sexuality in heterosexual relationships to co-exist in the present epoch - though they may be contradictory and none is hegemonic:
- the "male sexual drive" (MSD) discourse, which emphasises

men's (supposed) sexual needs;
- the "have/hold" (HH) discourse, which stresses that sex should take place within a lasting relationship with spouse/partner; and
- the "permissive" discourse, based on the assumption that sexuality is entirely natural and should not be repressed.
A fuller description of these discourses and evidence for their salience, in the form of quotations from influential magazines, and from "authorities" is provided (1984, pp.231ff. and 1989, pp.54ff.).

The first two discourses are gender-differentiated, in that taking up particular positions is "differentially available" (1984, pp.236, 259) to men and to women. (NOTE 15) Hollway also mentions but does not specify the "feminist" discourses which offer alternate bases for action and readings of actions (but see also Hollway, 1989, p.54 and the detailed discussion of Will below). Practices i.e. actions (NOTE 15a) may signify differently, if read through different discourses; for example, having sex with someone means something different within the HH discourse than it does in the permissive (1984, p.233).

In seeking to avoid discourse determinism, Hollway argues that the social availability of a position in discourse must be accompanied by an investment ("Besetzung" in Freud) to take up the position. This means there will be some "satisfaction" for the subject in taking up a particular subject-position, though this satisfaction may be in contradiction with other resultant feelings (e.g. guilt), and the investment may not necessarily be a "rational", nor a conscious "choice" - yet "there is a reason" (1984, p.238). Satisfaction may come, say, from the conferment of power, or from the confirmation of the continuity of "identity".

Positions available in gender-differentiated discourses confer relative power by enabling the suppression of significations which would be undermining of power (1984, p.239). Expressed significations co-exist with, and may cover for, suppressed significations; e.g., "sex" as a male need from the MSD discourse may cover for "sex" as intimacy in the HH discourse. There is a continued investment for the man in defining the woman as subject in the HH discourse, thereby suppressing his own wishes to have and to hold: in this way, he avoids being let down or hurt, and therefore he remains powerful (1984, p.247).

Also relevant to power relations are defense mechanisms, especially those discussed in the work of Melanie Klein. For example, as has been illustrated above (see previous section), <u>splitting</u> is a mechanism whereby gender-differentiated characteristics are located in one partner, e.g. the expressing of feelings in the woman. This involves a repression by the man of his feelings through projection and a consequent position as powerful, rational, supportive. This position is invested in that it protects the vulnerability of the man; it is conditional on positioning the woman as having the feelings (perhaps through her own introjection). Here, splitting works not as a permanent accomplishment of socialisation of one individual, but as a <u>dynamic</u> and <u>inter-subjective</u> process.

In the discussion of Taylor's work above, we found that "bread" was a key signifier in the lives of at least two boys in the Soweto study. A similar illustration relating to the signifier "oranges" - though rather more idiosyncratic - is provided by Hollway (1984, pp.250-51 and 1989, pp.58-59). A woman, during a phase when she was not paying her male partner much attention, noticed that he was "getting at her" in little ways, that seemed antagonistic. When they tried to discuss it, at first he came up with a "blank". Then, "oranges", as if from nowhere. After he reflected a bit, the woman explained,

> he said it had something to do with his relations with women. If a woman peeled an orange, it showed that they cared for him. Then he said that his mother used to do it for him, even when he could do it for himself.
>
> (1984, p.250)

Here, "peeling oranges" has meanings for the man which are not rationally or culturally accessible through, say, the definitions of oranges or of peeling. In Lacanian terms, the signifier "oranges" , fallen to the level of the signified (i.e. repressed), is part of the metaphoric axis whose links are formed by desire. Through condensation and displacement, it connects to a wider set of meanings around proof of loving and of caring, through women doing things for him. It is connected with a suppressed signifier established early in his particular history, through its links with his desire for the unconditional love of his mother. And it is part of the signifying chain from mother to other, which, according to Freudian theory, is "historically [i.e. biographically] unbroken for men, though savagely repressed" (Hollway, 1984, pp.250-51; 1989, p.58). Thus, the significations occupied by desire may be idiosyncratic, but they are not arbitrary, for they are a product of a person's history.

In Hollway (1989), several case studies are presented, to do with various decisions made by several couples; e.g. making love without contraception, getting married, and having an abortion. She focusses especially on the positions taken up by Will, one of the main characters. Will is described as

> able to go beyond the comfortable obvious account because of various <u>influences</u> both outside and within the research. First, for some time Will has moved in networks where it is <u>taken for granted</u> that he he will speak and act within the meanings produced by feminist discourse....
>
> (Hollway, 1989, p.81, my emphases)

That is, he is <u>positioned</u> in this and the other discourses, namely, conscious raising work done within his couple's relationship with Beverley, and humanistic groups whose general aim was self-knowledge.

Will's accounts of the discussions with Beverley early in their relationship about whether to have a baby or to have an abortion, seem to bring up two "positions", which Hollway calls respectively "the woman's right to choose, ... a manifestation of Will's anti-sexism in the current political climate", and the "I want a child" position. The first we could see as related to the feminist discourse mentioned above, but the second is more difficult to locate. It could be related to Will's putting himself as subject in the have/hold discourse - or perhaps to a type of "paternal" discourse (likely to have been learnt early in life, through identification with his father). Thus we could say that Will is able to be positioned in several discourses in the accounts he gives of his actions in the humanistic groups and in the research interviews - especially in the feminist and the humanistic discourses. At the same time when considering particular decisions, we could also say that he calls up other discourses as part of the mix of discourses in play; for example, his desire for a child may have some basis in the have / hold discourse, or in what I call a "paternal" discourse.

This gives a basis for seeing two aspects to the process of positioning in / calling up discourses. He is positioned in the feminist and humanistic discourses since they hold sway - it is "taken for granted that he will speak and act within" them, and he is thus to some extent "regulated" by them - in the contexts in which the research is being conducted. These discourses also hold sway in those (not entirely disjoint, as Hollway explains (p.81)) contexts - such as his relationship with Beverley - in which the activity is played out, which relates to the decisions discussed. At the same time, he is able to call up others such as the "have / hold" or "paternal" discourses (see above) because he has access to them, but he is not positioned in them with the same immediacy.

Hollway's work on gender relations allows us to develop the idea of particularity, as related to affect and subjectivity. It provides a number of examples of how signification works within discourses. And it helps me clarify the processes of positioning and calling up.

8.5 Summary

Much previous research on adults and cognition has tended to ignore, or to play down, the importance of mathematics anxiety, and of affect generally; this can be seen in most of the research reviewed in Ch.7. On the other hand, recent studies which have focussed on maths anxiety (or maths affect) have exhibited differences in their ideas on the nature of maths anxiety, whether or not it is measurable in quantitative terms, and its relationship with cognitive activity and performance (Sec. 8.2).

The studies discussed in the last two sections which have been influenced by psychoanalytic and/or post-structuralist ideas have taken distinctive positions on these issues. Those influenced by post-structuralism do not see maths anxiety as an individual characteristic - so that to "have it" would tend to mean being pathologised (or subject to "victim-blaming") - but rather they see it as dependent on the positions in the discourses of school mathematics that are "available" to young people, boys and girls, and how they are "regulated" within them. For example, Walkerdine and others have argued that many crucial terms in these discourses, such as activity, "flair", rule-breaking and rationality tend to be "gendered", i.e. seen as "masculine". This makes it difficult for girls to be positioned as active or brilliant; indeed as the girls approach puberty and beyond, they are in a double-bind in that success in "masculine" activities such as school maths and science, may signify a "lack of feminity". (This can be seen as the basis of the "fear of success" described by Horner (1972).)

The theories of the psychoanalysts have stressed the importance of the unconscious and the defences in attempting to assess anxiety and to understand its effectivity. Because defences may operate so as to distort (or occlude) the expression of anxiety, it is not necessarily observable (in any straightforward way) - let alone available for self-report. Hence we may need to look for evidence of the operation of defences - in jokes or "slips", or in fantasies or in "free associations" - and to allow for the possibility that anxiety may be presented as "no feeling at all", or even as a different feeling. (These issues will be taken up in Ch.9.)

The work of Walkerdine, Taylor and others has provided the basis of seeing affect or emotion as specifically related to the practice called up. In order to appreciate the affective meanings of "mathematics" for instance, we need to consider the ways in which the particular subject has been positioned in discourses which involve "mathematics". The task is made more challenging for various reasons: one is that the salience of mathematical - or more broadly, of quantitative or spatial - ideas in this culture means that the signifier "mathematics" may connect frequently with chains of signification in the unconscious. (These ideas will be illustrated in Ch.11.)

Taylor describes the way that the performance of two of the 13-year-old boys seems to depend on the "clarity" (or in my terms familiarity) of the practice called up in response to different problems: thus the boys appear to reason better when using a culturally embodied strategy based on everyday practices than they do when using an abstract strategy, based on calling up school maths. Taylor is not saying simply that "positive affect leads to better performance" in general, but rather that having a positive affective charge means a discourse is more likely to be called up, and familiarity (with the discourse) means clearer thinking and better problem-solving. All these aspects must be considered as a whole for a specific practice and for particular subjects.

Walkerdine describes a shopping game at school where it appears that positive affect in the form of pleasure is mobilised; this is pleasure, she implies, both at the conscious level and in terms of the way that unconscious desire invades the meanings in the fantasy of being an omnipotent customer. However, despite the pupils' enjoyment of the shopping game, Walkerdine surmises that they do not learn much mathematics. They are positioned in a complex interdiscursive way, and the fact that the "game" provides so much pleasure means that the pupils are unlikely to call up school maths, which Walkerdine argues would in fact require suppressing the metaphoric axis of shopping - and the associated pleasure.

The ideas discussed here can help us to understand more clearly the dynamics of certain situations. For example, let us reconsider the example of Archie, the boy with a "learning disability"; see Sec.8.1 above, and Cole and Traupmann (1979). It will be recalled that, in two incidents, an individual testing and a quiz at the after-school club, Archie displayed signs of "distress", which seemed to lead the tester and the quiz-master, respectively, to let Archie answer a question under non-standard conditions, or to ask a less difficult question. this leads to several questions:
(a) What is the "distress" that Archie gives off, and why?
(b) What are the responses that he brings up in other people, and why?

From the description by Cole and Traupmann, it is reasonable to interpret Archie's responses - head lowered, pulling at his sleeves (p.29), head bowed, appearing to cry (p.30) - as anxiety. (This anxiety seems to be "manifest" in both cases though it is not reported or "expressed" as such by Archie.) As for his reasons, Walkerdine conjectures that he "consciously or unconsciously manipulates the other participants in the interaction so that they both help him and perpetuate his disability [...] because he presents various signs to be read ...." (1988, p.52).

As for the others' responses, Walkerdine suggests that it is necessary to examine the "relational dynamics in terms of their emotive power and the production of anxiety which is read [... and] the production of that anxiety within Archie's own history" (p.53). The relational dynamics can often be studied by referring to field notes and recordings of the particular episode. Here, using insights from psychoanalysis, it is possible to ask whether the tester's decision to give Archie a less difficult question (or conditions) might have been made for reasons of which she was not fully conscious - to do with defenses against her own anxiety or "emotional distress". (NOTE 16) In my discussion of the interviews (see the case study of Ellen in Ch.11), I shall illustrate how an analysis which is sensitive to such relational dynamics can be accomplished.

Finally, I sum up the ideas on positioning and calling up developed in the last two chapters. It is a major idea of the thesis that problems can be recognised and thought about, and a solution produced, only within a particular context - and that the relevant context is constituted by one or more discursive practices. Thus it is clearly important to be able to say in which practice(s) the subject is "positioned" when confronting particular problems, in an interview or other setting.

However, answering these questions is not at all straightforward. It requires relating to very complex ideas about subjectivity, where the terminology is very slippery, and there is a continual risk of being taken back to theories with commitments from which the analysis had aimed to break free. As has been suggested most explicitly in the account of Walkerdine's and Hollway's work in the last two chapters, it requires going beyond both the work of Foucault and that of psychoanalysis. Foucault has described the positioning of subjects in social practices, but still lacks a satisfactory theory of subjectivity; the psychoanalysts have addressed subjectivity, but tend to ignore its social / historical dimensions.

The problem is that there are two "aspects" or "stages" - neither term is totally satisfactory - of the process. In any particular situation, certain discourse(s) are "in play"; we say that it / they <u>position</u> any person acting in that setting, because the discourse(s) are used to "read" - describe, interpret, evaluate, regulate - these persons' activities, and power is exercised in these processes. Much of Foucault's work (e.g. 1977, 1979) was oriented to describing such subject-positions; also Hollway has argued that certain positions in gender-differentiated discourses tend to be more available to males or to females. So far, positioning seems rather determinist: any particular female, say, or any particular white middle-class female, should be positioned in much the same way in a given discourse. However, this is where subjectivity comes in. In any situation, the play of signifiers in language is such that a particular subject may call up - recognise, think of, recall - one or more different discourses that may also be used to examine, understand and resolve any problem. This will depend on the complex of "investments of desire" that the subject has, which will depend in turn on his/her "history"; see for example Hollway's story in the previous subsection, where desire invests particular chains of signification where the signifier "oranges" is central.

Even deciding how to call the process is complex. "Being positioned" emphasises the determined aspects of the process, and "calling up" the "voluntarist" or freely chosen aspects. Talking about them together, as aspects or stages of a process, is an attempt to get away from either tendency towards one-sidedness. Thus I am attempting to go beyond the analysis of Henriques et al. (1984) and that of Hollway (1984). "Being positioned" emphasises that the person may have no choice about being "subjected" to a reading of his/her "performance" through the particular discourse, nor may they be able to offer resistance to the power exercised in social relations by others. For example, Walkerdine describes her powerful position as an experimenter reading the performance of cognitive tasks by some pupils who had been told they were playing a "game" (1988, Ch.3, pp.48-60). On the other hand, even those who might appear in general to be "less powerful" may attempt to call up a different discourse, and thereby to vary their positioning in certain contexts; for example, the two little boy pupils who challenge their teacher by using signifiers from sexist discourses (see Walkerdine and Girls & Maths Unit, 1989, pp.65-66).

In the light of the discussion in the last two chapters, what can be said about a subject's positioning, in particular discourse(s), in a specific situation, such as one of Taylor's interviews, or one of mine? This seems to entail several questions:

(1) What is the range of specific discourses available?

(2) What determines the positioning of the subject at any point?

(3) What indicators are there for the subject's positioning?

Only a general response to (2) will be given here, since my interviews are described only in the next chapter (and all three questions will be more fully discussed in Sec. 10.1). We can say that the subject's positioning is:

not determined (only) by the subject's place in a structure according to class or gender - i.e. social structural determination - though it is affected by such social differences;

nor determined (only) by the discursive features of the situation e.g. the wording of the questions - i.e. discourse determination - though it is constrained by these.

Nor, on the other hand, is it freely chosen by the subject; and it is certainly not necessarily "rationally", or even consciously, chosen: it is subject to the operation of (possibly inter-subjective) defense mechanisms, and to "investments of desire".

The subject will generally be multiply positioned in some "mix" of discourses (NOTE 17) and in a fluidly changing way - and hence one must describe this positioning at crucial points of an interview (or other social interaction), rather than attempting to describe some "overall" positioning for each subject.

Thus in this chapter, I have begun to sketch an alternative view of maths anxiety and mathematical affect generally. Affect is specific to specific discursive practices in the sense that it invests or infuses particular signifiers, in chains which may be linked with unconscious ideas. The views developed in the last two chapters provide the basis of the themes highlighted for investigation in the interview phase of this research. They also have implications for the way the interviews were conducted, recorded and analysed. I go on to discuss both themes and interviews in Ch.9.

CHAPTER 9 : METHODOLOGY OF THE INTERVIEW

> Those who lack the skill even to calculate 10 per cent are surely handicapped when attempting to understand the affairs of society.
>
> (Sewell, 1981, p.17)

In Chapter 1, I presented a list of objectives for this thesis. The following is a selection of those aims which seemed able to be pursued using an approach based on semi-structured interviews:

(iii) to consider critically a number of "truths" about mathematics performance, numeracy and anxiety which are widely considered to be valid; for example, "Males perform better than females....", "Women have more maths anxiety..." and "Mathematics anxiety is debilitating";

(iv) to review the conceptions of "context" used in research in mathematics education and psychology, and to assess certain of these conceptions through empirical research;

(v) to contribute to the development of ways of describing cognition and affect in context, by proposing a methodology drawing on ideas from post-structuralism, and aiming to determine the practice(s) called up by subjects when they are presented with numerate problems;

(vi) to document the range of affect related to mathematics and numbers amongst members of the sample;

(vii) to illustrate the contribution of insights from psychoanalysis in the study of affect generally, and of anxiety in particular; and

(viii) to examine the relationship of cognition and affect, both across samples of adults, and for particular subjects.

Aims (iii), (vi) and (viii) have already been investigated using the results from the survey. However the discussion of those results in Chapters 5 and 6 and the Interlude raised a number of issues that are further considered here in the second part of the thesis.

In this chapter, I draw on those discussions, and on the literature reviews in Chs. 7 and 8 to produce a list of themes for the next 3 chapters; since these are set down to provide a set of directions or focusses for the production and analysis of the interview material, they might also be termed "foreshadowed problems"; see Sec. 9.1. In Secs. 9.2 and 9.3, the aims, methodology and execution of the interviews are discussed and justified. Finally, in Sec. 9.4, an overview of the analyses to be carried out in Chs. 10 and 11 is provided.

9.1 Themes or Foreshadowed Problems

(1) Context understood in terms of positioning in practices

In Chs. 7 and 8, an alternative way of thinking about the context was developed. Rather than simply naming the context, or describing a situation briefly in a questionnaire or performance item, it was argued that the context is constituted by the discursive practice(s) (or activities) in which subjects are positioned. Developing earlier work, I claim that, given a specific situation such as the interviews I conducted, it is possible to say which practice is called up in response to particular questions. Using the interviews, I explore and develop these ideas.

(2) the inseparability of task and context

In Ch.2, I distingished between traditional ("transfer) views and "utilitarian" views represented by The Cockcroft Report and by Brigid Sewell on the basis of their notions of context and of numeracy (see Sec. 2.1). In the traditional approach, there is still a tendency to see abstract questions formulated in the school maths context as the "same" as others formulated in practical terms - if the mathematics which can be abstracted from both can be seen to be the same. In the utilitarian approach, the wording of the problem is normally assumed to be sufficient to position it in the school maths (SM) context, or alternatively in a "practical maths" (PM) context.

In Ch.7, an alternative set of views was presented: cognition, task and context were seen as a whole, and therefore there was a <u>discontinuity</u> between school maths problems and what I call numerate problems in practical, everyday contexts. The traditional, utilitarian and alternative views of the relationship of cognition and context relate to the N0, N1 and N2 views of numeracy, respectively.

Therefore we might explore these three views empirically, by making two comparisons:
(a) comparing each subject's positioning for two items where the "mathematical content" appears to be the same, but where the situation described in words is different; and
(b) comparing each subject's positioning for two items where the mathematical content and the situation described seem the same, but where other aspects of the context (e.g. questionnaire test vs. interview relations) differ.
This will allow us to confirm the importance of considering the task (and cognition) in context, broadly understood, as in N2 (see Ch.7).

(3) Structural (gender, social class) differences in performance understood as differences in positioning within practices

In Ch.2, research findings of gender differences in maths test performance were discussed. In the analysis of my questionnaire results, the initial gender differences found were substantially reduced when controls for qualification in maths, age and social class were introduced. Given the emphasis in the last two chapters on gender differences in positioning in mathematics and other discourses, it is useful here to explore any observed gender differences in performance, by considering the way that men and women might be positioned differently in everyday practices.

Although social class differences found in Chs. 5 and 6 were smaller, social class differences in performance in the interview will be examined in a similar way.

(4) Numerate cognition as specific to the context

More generally, the context-specificity of numerate thinking and performance will be examined by considering differences related to different positions in discourse. Differences in cognition will relate to "correct performance", and to strategies and methods used.

(5) Gender differences in expressed anxiety

Earlier research has sometimes shown gender differences in anxiety expressed in self-report questionnaires (see Ch.3). More recent work has included not only studies of "gender identity" done by femininsts such as Hollway (1984, 1989) (see Ch. 8), but also studies attempting to develop insights into the construction of a "masculine identity" (Tolson, 1977; Metcalfe and Humphries, 1985; Segal, 1990). It is not possible to consider here the wide range of issues raised in these works, but only the points that are relevant to maths anxiety.

First, these studies confirm the view that men are often less willing - or less able - to express their feelings openly than women (e.g. Tolson, 1977, p.18). Second and more generally, inasmuch as a man, or a woman, can be positioned in other ways, e.g. in social class terms, they may be subject to contradictory positionings; this itself may tend to generate anxiety because of the simultaneous positionings of power and powerlessness (Henriques et al., 1984, p.225), or intrapsychic conflict more generally (see sec. 9.2.3).

I shall explore the idea that men have more difficulty with expressing their anxiety than women in the interviews. However, views expressed in the last chapter (e.g. Freud, Legault) suggested that anxiety is not necessarily fully conscious, and hence it may be necessary to attend to symptoms, or indicators of the functioning of defences. In this connection, Carl Rogers (1971) has made a distinction that is potentially valuable: between expressing a feeling and exhibiting it without expressing it. This takes on board the idea that the subject may not report a feeling, or indeed may not even be aware of it.

Threfore, I shall also explore the hypothesis that, rather than expressing anxiety, men may tend instead to "exhibit" it - e.g. by speaking in an "unusual" way, or by being impatient to know whether he got the answers "right" (to the problems set). This raises the issue of valid indicators for anxiety; see sec. 9.2.4.

(6) Other feelings expressed or exhibited

Because anxiety may be expressed as something altogether different - e.g. confidence - or else suppressed or expressed as nothing at all (see last chapter), it is important to examine other expressions of feelings, or indications of the operation of defences against these. Of particular interest are expressions of confidence (see Ch.3), pleasure (Walkerdine, 1988), and anger (Frankenstein, 1989, Ch.2).

(7) Anxiety and other feelings as specific to the context

In the same way that traditional and utilitarian researchers have chosen to see many numerate tasks as "in essence" mathematical, so too many researchers interested in affect have considered that the items that they have labelled "maths anxiety" have concerned essentially those areas. However, if the context of a particular action is seen as not "mathematics" (or as not only mathematics), then any anxiety or affect expressed (or exhibited) is not (only or necessarily) "maths anxiety" or maths affect. Therefore we need to consider cases of what may appear to be maths anxiety in terms of subjects' positioning in practice(s).

(8) The relationship between affect and performance as specific to the context

In the statistical modelling reported in Ch.6, a relationship between anxiety (measured by Rounds and Hendel's math course / test anxiety scale) and performance (measured by the school maths items) was proposed as a <u>general</u> relationship, and the relationship produced resembled somewhat the shape of an inverted U. However, in the Interlude following Ch.6, I noted that the generality of this proposed relationship was limited because of its limited fit with the data, and also that the direction of causality might be problematical. Hence there was a need to consider the relationship between cognition and emotion for particular subjects and for particular episodes of action.

The discussion in Ch.8 has cautioned against simple conjectures about the relationship between cognition and affect: familiarity with an object or site does not guarantee a positive affective charge, nor does positive affect necessarily lead to better thinking or performance (see the discussions of Adda, Taylor and Walkerdine in Secs. 8.4 and 8.5). In order to appreciate both the affective meanings and the quality of cognition and performance, we need to understand the positioning of the subject. In these analyses the examination of "slips" or surprising errors will be useful. Also I shall examine familiarity as an important concept straddling the cognitive and the affective.

In Sec.9.4.2 below, the methods to be used for analysing each of these themes will be discussed. Because the argument in the last two chapters has emphasised both the structural (i.e. gender, social class) specificity of positioning, and also the particularity of cognition and affect for each subject, the methods of analysis for themes such as (3), (4), and (5) will be based both on cross-subject analysis and on within-subject case studies (see sec. 9.4.1).

9.2 <u>The Interview Method</u>

9.2.1 Developing the Interviews

The objectives of the thesis which were to be pursued using the interviews are given at the beginning of this chapter. Among these was (v) "... describing cognition and affect in context...". This suggested an ethnographic approach to the interviews (Hammersley, 1979; Hammersley and Atkinson, 1983). (NOTE 1)

The central methodological concerns of ethnographic research include:
- <u>understanding</u> of the goals and purposes of the actors, and of the meanings they perceive in events, institutional arrangements, etc. - hence the need to describe the perceptions of (various groups of) the subjects themselves;
- <u>holism</u>: the actions of individuals are motivated by events within the larger (subcultural or organisational) whole - hence the need to describe social activity within its context; and
- <u>reflexivity</u>: social researchers are part of the social world studied - hence the need to document the "relational dynamics" involved in the production of the data. (Atkinson, 1979, pp.46ff.; Hammersley and Atkinson, 1983, Ch.1)

Having provisionally settled on a broadly ethnographic approach, I then considered the method of interviewing. The objective of describing cognition and affect in context could be broken down into the following:

(v1) describing numerate thinking and performance, both as recalled by the subjects themselves and as produced in the interview;

(v2) describing emotion and especially anxiety, both as produced in the interview and as reported by the subject in connection with earlier experiences with numbers or maths;

(v3) describing the context(s) in which the interview was taking place, both in terms of the setting and also particularly in terms of the subject's positioning in practices during particular episodes; and

(v4) describing the relationship of cognition and affect in context.

I considered several types of interview. Objective (v1) suggested the use of "protocol" methods focussing on problem solving; these methods include "talking aloud", as well as Piagetian "clinical interviews" (Ginsburg et al., 1983; see also Ginsburg and Asmussen, 1988). However, it did not seem that such interviews provided the most effective way to allow emotion to be produced or reported, as required for objective (v2). Therefore I considered the range of "clinical interviews" concerned with "broad underlying feelings or motivations, or with the course of the individual's life experiences" (Selltiz et al., 1959, p.266): the most appropriate seemed to be the "life history" approach (e.g. Hammersley, 1979) - though this appeared to have the disadvantage that repeated unstructured interviews with each subject were called for. Yet, in single interviews designed to elicit affective material, Celia Hoyles (1980, 1982) was able to ask secondary students to tell her a "good story" and a "bad story" from school, and to analyse those stories to do with mathematics.

In seeking to find or produce a method that would allow me to pursue objectives (v1) and (v2) I had noted the potential in Brigid Sewell's (1981) interviews for the Cockcroft Committee: she asked respondents to attempt some everyday numerical problems and noted not only their answers, but also what sorts of emotional reactions came up (see Sec. 7.1). Also Laurie Buxton chose an interview strategy where he would present his adult subjects with mathematical problems so as to "induce some of the feelings, though hopefully not at too stressful a level, that I was concerned to study" (1981, p.131). This sort of strategy would certainly be useful for objective (v4).

With these possible approaches in mind, I constructed an interview strategy which aimed to study the students' thinking about a set of questions, and their affective reactions, as well as the setting - in terms of the practices in which the students were positioned. This strategy was based on a combination of the life history approach with a problem-solving approach similar to that of Sewell (NOTE 2) - with the crucial addition of "contexting questions" for each problem, meant to help synthesise the two approaches. See the fuller description in the rest of this section. (NOTE 3)

9.2.2 Areas for exploration and questions chosen

My synthetic method for the interview used three types of questions: life history questions, problems to be solved, and contexting questions.

Life history questions focussed on the following areas:
- gender, age, social class position and degree specialisation (including any changes since enrolment);
- qualifications passed (or attempted) in mathematics;
- recent studies and the use of maths in them;
- recent paid work and the use of numbers involved; and
- other salient aspects of the repondents' use of and experience with maths and with numbers in education, work, and everyday life.

In the event, even the apparently "factual" life history questions allowed the respondent to tell stories about experiences with, and feelings about, maths and numbers in a range of contexts.

In problem solving, for each problem offered, I asked:
- how the subject was thinking about the problem; and
- his / her answer.

Nine questions were used in the interviews, six adapted from those of Sewell (1981), and three constructed by me. On the basis both of my experience in teaching entrants to the social science degree, and on views within mathematics education - see for example the passage in Sewell (1981, p.17) quoted at the head of this chapter - the topic of percentages was considered to be the most "fruitful" maths topic to use in the interview. Thus four questions on percentages were offered: one "abstract" 10% (Qu.2), and three "practical" questions - calculating a 10% tip (Qu.4); estimating, then calculating exactly, a 9% rise for a wage slip (Qu.5); and calculating the effect of a 10% cut in course tutorial times (Qu.8).

In addition, there were two questions on reading numerical information: one on a pie chart (Qu.1); and one on reading a level and comparing rates of change on a line-graph (Qu. 3). Finally, on topics that might be called consumer arithmetic within a school maths syllabus - or, instead, numerate aspects of shopping, cooking, etc. - there were three questions: choosing a "best buy" from two bottles of ketchup (Qu. 6); calculating the cost of baking a cake from a recipe (Qu. 7); and calculating one person's share of the costs of the uniforms for a team (Qu.9).

The problems to be solved themselves were arranged in a particular order: Qu.1 on the pie-chart was considered as an "ice-breaker" (because it seemed exceedingly easy), and Qu.2 was the only problem which was considered "abstract" in the design of the interview. Qu.3 and subsequent problems were considered practical. (NOTE 4)

There was an attempt to use only problems that were "balanced" in their interest and appeal to men and women. However, Qu.7 on the cost of baking a cake was considered exceptional in its bias towards what have been traditionally considered "feminine" interests. Therefore Qu.9 on the cost of sports kit was constructed to re-establish a rough "balance" in gender terms. (NOTE 5)

Finally, for every problem, two contexting questions were posed. At the moment when each problem was first presented, I asked "what sorts of other activities that you do currently it reminds you of". And after the subject's thinking about the problem and giving their answer, I asked "what sorts of earlier experiences with numbers it reminds you of, or feelings it brings up".

The use of contexting questions was an innovation in my interviews - as compared with Piagetian clinical interviews or Sewell's interviews, for example - and their use followed from the theoretical discussions about positioning and calling up in Chapters 7 and 8. The contexting questions were aimed to provide information on what practices the subject was recalling in response to each problem posed, as the interview unrolled. Their responses provided the data supporting my judgments about which practices had been called up. I aimed not to lead the respondent to call up school maths, rather than an everyday practice (or other school subject). In fact the first contexting question was designed to allow the subject to state, and thereby to affirm, the practice(s) recalled, before any numerical or "mathematical" question had been posed.

For the full set of questions and problems used in the interviews, see Appendices I1 and I2.

9.2.3 Psychoanalytic insights in the interviewing

Hunt (1989) has contrasted the psychoanalytic perspective in social research with classical ethnographic views in terms of the distinctive assumptions of the former:
(a) much thought and activity takes place outside of conscious awareness; thus, everyday life is mediated by

unconscious images, fantasies, and thoughts - which sometimes appear as jokes, slips, dreams, or subtly disguised as rational instrumental action;
(b) the unconscious meanings which mediate everyday life are linked to complex webs of significance (or, we might say, signification) which are ultimately traceable to childhood experiences; and
(c) intrapsychic conflict (among id, ego, superego - or among desires, reason, ideals, norms) is routinely mobilised vis-a-vis external events, especially if they arouse anxiety or link to unresolved issues from childhood (p.25).

A very general implication of (a) and (c) is that any product of mental activity, - including interview talk - may, upon deeper investigation, reveal hidden aggression, (I would add) suppressed anxiety, forbidden desire, and defences against these wishes (p.25). An important implication of (b) is that transference, the imposition of "archaic" (i.e. childhood) images onto everyday objects (people and situations), is a routine feature of most relationships. Hunt uses the term "transference" to describe the unconscious reactions, to the other, of either subject or researcher (since the latter is in psychoanalytic terms, also "lay", unlike the analyst in a therapeutic relationship). Thus, unconscious aspects of communication may affect empathy and rapport in the fieldwork interview; for example, transference may facilitate, or blind, the researcher's understanding of some dimensions of the subject's world. Transference on the part of subjects onto the researcher is especially likely where a close, long-term relationship between researcher and subject develops (p.76).

As indicators of the functioning of defenses against intrapsychic conflict, she cites: denial e.g. of sexual aspects of research encounters, jokes, slips / parapraxes (failures of memory, speech or action which would normally be performed successfully), "symbolic" gestures, dreams and fantasies (pp.69-76). As indicators of transference, she points to the expression of strong emotions, such as anger, love, anxiety, shame, annoyance, boredom (pp.61-62).

Hunt offers a number of recommendations about the conduct of field research which are useful for our purposes here:
(1) researchers should routinely attend to and record "new" sorts of data, e.g. on fantasies, dreams, jokes and slips;
(2) the researcher needs to be sensitive to possible significance of dreams reported by subject, where the researcher appears clearly, or thinly disguised and to descriptions of other persons or experiences which resemble some aspect of the researcher, or the research setting;
(3) in order to allow for the possibilities of transference, "reflexive accounts" need another, deeper dimension - especially where a close relationship between researcher and subject has developed;
(4) the researcher needs to use introspection on his or her own emotional responses to subjects, and to be sensitive to the possible significance of fantasies or dreams, for evidence of transference.
(5) the researcher needs to be prepared to conduct unstructured, "free associative" interviews, following stressful events - or (I would add) instead of them, if the planned interview schedule itself becomes too stressful.
Examples of the use of these recommendations will be apparent in the discussion of the interview results in Chs. 10 and 11.

9.2.4 Developing indicators for performance and anxiety

First of all, the indicators used to describe performance / cognition varied from question to question, but generally included the following:
- the language used by the subject while thinking about the problem, in particular, whether any terms were used which might indicate positioning in a specific discourse; for example, for Qu.3 (reading a graph showing changes in the price of gold over a day's trading), use of the terms "graph" or "gradient" would tend to indicate positioning in College maths, whereas "chart" or "trend" might indicate "money maths" or a business discourse;

- the subject's manner of describing her/his thinking, in particular, whether any emotion was expressed or shown, e.g confidence or anxiety;
- the broad strategies used, e.g. rules for tipping in Qu.4, unit price or other comparisons in Qu.6; and
- procedures or methods used, e.g. written vs. "oral" approaches, ways of approximation in Qu.5; and
- the apparent correctness or cogency of the response, within the discourse apparently called up.

As for anxiety, in this research, I adopted Carl Rogers' (1971) distinction between expressing a feeling, and exhibiting it without expressing it (see hypothesis (5) in Sec. 9.1 above). I developed the distinction, in order first to allow for the idea that simple self-reporting or expression - the basis of both of the major maths anxiety scales, and hence of most of the maths anxiety research (see Ch.3) - might not be a valid way to measure anxiety. I also saw the idea of exhibiting anxiety or other feelings as going some way towards taking on board Freudian ideas about defenses distorting or occluding the expression, and indeed the conscious awareness, of specific feelings such as anxiety - thereby keeping open the possibility of empirical study of the affective area.

An illustration of the problem is given by the growing realisation by an interviewee in another study, that

> ... The very signs I took to signify confidence were, for him, [...] actually the signs of his lack of confidence, like - talking too much ... being opinionated and things that I couldn't bear. And when I read it back as lack of confidence, I could see ....
>
> (Hollway, 1984, p.248)

Indicators for expressing anxiety appear to be relatively straightforward: they would include statements by the subject of the form "I feel anxious, scared, unsettled ..." (at this moment or generally these days) - or "I felt anxious, scared, unsettled ..." (at that time in the past, or generally in that period).

It seems less straightforward to specify the indicators for exhibiting anxiety. To be more precise, following Legault (see sec. 8.3.2) and Hunt (see sec. 9.2.3), I was looking for indications of defences against anxiety, or other intrapsychic conflicts. Several sets of indicators were pointed to as promising:

(i) "Freudian slips" (parapraxes): e.g. slight (but possibly "motivated") mispronouncing of words or forgetting of a name (Freud, 1901/1975); included in this category might be a "surprising" error on one of the interview problems, given the student's previous experience (for an illustration see the results of Ellen's interview in Ch.11);

(ii) denial (or what might be denial) of anxiety: e.g. "protesting too much", making an assertive "statement" that the subject feels exceedingly confident about maths - or on the other hand, feels nothing about maths (for illustrations, see the accounts of Ellen's, and of Alan's, interviews, respectively, in Ch.11);

(iii) behaving "strangely" or unusually: e.g. laughing a lot, especially "nervously", talking unusually quietly, or unusually loudly, or making striking symbolic gestures, or ... - note that the set of all conceivable indicators is not specifiable in advance here (for illustrations, see the interview report in Ch.11 on Alan);

(iv) impatience to know the "right answers" for the set of interview questions; and

(v) dreams and fantasies - though these seem unlikely to emerge in a single interview with students that the researcher knows at most only moderately well. (NOTE 6)

9.3 Execution of the Interviews

A total of 25 interviews were conducted in the summers of 1985 and 1986, i.e. at the end of the 1st year for the 1984 and 1985 entrants, respectively. Because of the need to be flexible and to offer a range of interview times, the interviews were conducted only at the site of the institution where I had my office, i.e. only with students on the BA Social Science (BASS) (and not with DipHE students).

9.3.1 Sampling methods and recruitment

To begin with, I judged that interviews of 1/2 hour would be long enough to produce sufficient life history material and to allow most subjects to attempt 6 or 7 problems - and not so long as to deter participation. I aimed to do about twenty interviews, bearing in mind the work involved in conducting, transcribing and analysing them, and given that I had already produced substantial information in the questionnaires. In the event, I conducted nine interviews in June 1985 with students from the BASS 1984 entry, and 16 in June 1986 (BASS 1985 entry) - making a total of 25 interviews.

The 1985 interviewees were chosen by a combination of random and volunteer methods; this produced 9 subjects. In 1986, those to be interviewed were chosen by a process of stratified random sampling, in an attempt to enhance the representativeness of the results. The set of completed questionnaires from the autumn of 1985 was used as a sampling frame, and was stratified according to the three social structural variables found to be important in the statistical modelling - gender, age (18-20, 21+) and parental social class (middle class, working class and "mixed" - see sec. 5.6.1). Eventually, 16 students were interviewed. Thus a total of 25 students were interviewed in June 1985 and June 1986. For further details on sampling, see APPENDIX I5.

9.3.2 The setting and conduct of the interview

All interviews took place in my office. Some of the interviewees would have been there before for a maths subject tutorial, for a personal tutorial, or to see me in conneection with one of my other roles, notably as First Year Maths coordinator (see general reflexive account below). (NOTE 9a)

For further details on the conduct of the interview, see APPENDIX I5.

9.3.3 The general reflexive account

As argued in my discussion of Hunt's (1989) work on psychoanalytic issues in interviewing, if a researcher is going to assess the possibilities of transference, it is essential to produce "reflexive accounts" concerning his / her relations with key subjects in the setting. In this study, I dealt with this need by producing two sorts of reflexive account: a general one, given in this subsection for the interview phase of the research involving BASS students over two years, and a specific one for each student, which was part of the overall account produced for each interview; see Ch.11.

At the beginning of the study, I was already an experienced lecturer in statistics at the Polytechnic - though because most of my teaching was in the Social Science Faculty, I was strongly identified with that area, and especially with the BA Social Science. In the years when the interviews were conducted (1984-85 and 1985-86), I was very much involved with the first year Maths course (one of the strands in the "Methods and Models" course) - not only in giving some of the lectures, but also as the coordinator. In these lectures the team of staff attempted to re-introduce mathematics as a "cultural and historical product" (similarly to what was done in parallel strands of philosophy of science and computing), and to present it in a way that was exciting and that would reassure those who had had unpleasant earlier experiences with maths.

Thus, by June when the interviews were conducted, almost all of the intake of some 160 students would know me by name, and would have seen me in lectures at least. In addition, about a third would already have had me as a tutor for their Maths seminar group, or for Social Policy classes, or as personal tutor, in the first two terms; others might have met me in a special workshop for people with blocks in maths which I ran in the first term of these two years. (NOTE 10) Still other students would have me as tutor (in Maths) in the third term, or be expecting to have me as a tutor for 2nd year "Research Methods" paper for Social Policy or Social Work Track students.

In summary, in both of these years I would have been known to most students, and would myself have known up to half of them by name. Because of the quality of the Methods and Models Maths course, my "mathematician" colleagues and I were on good terms with most of the students - considering that most of them would have arrived with unpleasant associations with mathematics! And I personally had good relations with most of the students in those two years, especially those in my Maths seminar groups. Thus it was possible to expect that many, if not all, of the students would accept an invitation from me to an interview as described, and that in general they would basically trust my interest in their experiences with maths and numbers.

The letter inviting students to interview, and the script used for the interview itself, were expressed in terms of "research", "interview" and "numbers" - rather than "mathematics" or "test". Further, at the beginning of the interview, I emphasised to the student that he / she did not have to answer any question if they did not want to. This was part of my attempt to position both of us in a research, rather than a "college maths" discourse. (However, at the end of the interview, I did allow myself to be positioned as teacher in college maths - either by discussing "the answers" to the problems, if the subject asked this (a number of cases), or by offering a tutorial in the one or two cases where the student's thinking during the interview had indicated basic misconceptions.) See APPENDICES I3, I1 and I5.

Nevertheless, there was some variation in the extent to which I knew each student who presented him/herself for an interview, and in the relationship I had with them. In order to begin to assess the possibility of "transference" onto myself as researcher (see sec. 9.2.3), I rated each of the 25 students interviewed according to whether I "knew" them fairly well, was "acquainted" with them, or "did not know" them at the time of the interview. About one third were in each category. (NOTE 10a)

For further discussion of this issue, see the accounts of particular interviews, each of which includes a reflexive account, in Ch.11.

9.4 <u>Overview of the Analysis of the Interviews</u>

The preparation of the interviews for analysis involved several stages:

- transcription of the audio-tapes by expert typists;
- checking on the basis of my fieldnotes to improve the accuracy and completeness of the transcripts;
- preparation of a detailed account for each interview; and
- linkage with data from the (hitherto anonymised) questionnaires.

The data were then ready for cross-subject and single-subject analyses.

9.4.1 Cross-subject and single-subject analyses

Two sorts of analysis of the interviews were used. The <u>cross-subject</u> analyses aimed to produce summaries, frequencies and relationships of results considered comparable across the sample of 25 subjects. These analyses were inspired by Miles and Huberman's (1984) approach to analysing ethnographic and case study material, which is more systematic than most previous proposals for such analysis. (NOTE 11) The results included responses (broadly conceived) to interview questions, such as: the calling up of "school maths" or "business maths"; the type of thinking used, the "correctness" of answers; the expressing or "exhibiting" of anxiety; and so on.

The <u>single-subject</u> analyses aimed to produce detailed <u>case studies</u> and (shorter) <u>illustrations</u>, based on the life-histories and accounts given by selected interviewees. Here the webs of meaning linking practices, positioning, thinking, performance or "failure" to perform, anxiety, other feelings, and earlier experiences could be explored (always allowing for the limitations of the interview data). The data included: the subject's stories about their earlier experiences with maths at school or numbers at work; their current uses of maths and numbers; thinking, performance and affect in context; a fuller description of the context; particularities in thinking and affect.

9.4.2 Methods of analysis for each theme or foreshadowed problem

In this subsection, I set out the methods to be used for the analysis of each of the themes or "foreshadowed problems" set out in Sec.9.1. In Ch.10, I analyse those themes related to cognition, viz. (1) to (4), and theme (5) gender differences in expressing anxiety, through cross-subject analyses. The analysis of "cognitive" themes are based on the first six questions from the interview: Qus. 7 to 9 had too few responses. The rest of the themes related to anxiety and affect are based on single-subject analyses (case studies and illustrations) and therefore are found in Ch.11.

(1) Context understood in terms of positioning in practices

Several questions, particularly Qu.1 [pie-chart], are used to show how judgements about positioning are made. I also illustrate the interdiscursive positioning of some subjects. The method of analysis used is cross-subject analysis; see

(2) The inseparability of task and context

In Sec. 9.1 it was resolved to explore the traditional, utilitarian, and alternative views empirically by making two comparisons:
(a) comparing each subject's positionings on two items where the "mathematical content" appears to be the same, but where the situation described in words is different; and
(b) comparing each subject's positionings on two items where the mathematical content and the situation described seem the same, but where other aspects of the context (e.g. questionnaire test vs. interview relations) differ.

Thus for (a), performances on interview Qu. 2 (an "abstract" 10%) and Qu.4 (a 10% tip "contexted" in a discussion of tipping practices) were compared; for (b), the performance on interview Qu.4 and Qu.18 (a 10% "tip" on a sum said to be a restaurant bill) on the questionnaire. The method of analysis is cross-subject analysis; see Sec. 10.2.

(3) Structural (gender, social class) differences in performance understood as differences in positioning within practices

For Qu. 3 [graphs of price changes], I consider whether there are gender differences in the correctness of the answers given, and whether these are related to differences in maths qualification (as was done in the questionnaire analysis). I then ask whether these gender differences in performance are related to differences in positioning within practices. The method here is cross-subject analysis; see Sec. 10.3. Qu. 2 [abstract 10%] is considered similarly in APPENDIX U3.

At the same time, we must ask whether, despite their shared gender position, there are nonetheless differences <u>among</u>

women, say, in positioning within a specific practice, such as "eating out", which might be called up by Qu.4. This will be related to social class and ethnic group positioning, using illustrations; see Sec.10.4(a) and also APPENDICES U1 and U2. Differences among women in this activity will be further discussed using case studies in Ch.11. (Information about the breakdown of the sample of 25 on the basis of gender, social class (NOTE 12), age and qualification is given in APPENDIX I4.)

(4) Numerate cognition as specific to positioning

The context-specificity of numerate thinking and performance will be examined by considering differences related to different positions in discourse. Such cognitive differences may relate to "correct performance" - to be examined for Qu.4, methods for critical evaluation (e.g. of previous steps in one's thinking) - in Qu.5, and strategies used - for Qu.6. For the latter question, much of the interest centres on comparing my results with those of Capon and Kuhn (1979, 1982) and Lave (1988).

Here, both cross-subject analysis and illustrations (e.g. of critical evaluation) will be used; see Sec. 10.4.

(5) Gender differences in expressed anxiety

This cross-subject analysis will begin the examination of anxiety; it will compare men and women in terms of the numbers of subjects who <u>express</u> anxiety and/or who <u>exhibit</u> anxiety in their interviews. See Sec. 10.5.

(6) Other feelings expressed or exhibited

Initial analysis showed that the subjects of the interviews expressed or exhibited a wide range of feelings which, at first sight at least, had to do with mathematics, or perhaps the numerate aspects of some everyday practice. Hence the illustrations and case studies will examine examples not only of anxiety, but also of confidence (Ellen), pleasure (Donald, Harriet), and anger (Fiona, Peter); see Ch. 11.

(7) Anxiety and other feelings as specific to positioning

Just as the use of numerate or quantitative signifiers does not make the activity in the situation under consideration "mathematical", so too the anxiety (or other feelings) expressed or exhibited in such situations is not itself necessarily or wholly mathematical. Therefore I analyse two instances of what might appear to be "mathematics anxiety", using the case studies of Jean and Ellen (see Ch. 11).

(8) The relationship between affect and cognition as specific to positioning

In contrast with the statistical analysis (reported in Chs. 5 and 6) which aimed to produce a general relationship between anxiety and performance, it was argued above (see Sec. 9.1) that it was necessary here to consider the relationship between affect and cognition for particular subjects, and for particular episodes of action in the interview. In order to appreciate both the affective meanings and the quality of cognition and performance, we need to understand the positioning of the subject in the context of each task. Case studies and illustrations will provide the base of the analysis; see the next subsection for choices.

9.4.3 Choice of interviews as case studies

All interviews were analysed initially and drawn on for the cross-subject analyses. However, case studies, rather than presenting extended accounts for all 25 interviews, it was necessary to select a subsample of case studies. This choice was made on the basis of which interviews appeared to be most fruitful in terms of the issues raised by the list of hypotheses / problems, and was extended by attempting to balance the subsample on gender, age, and social class (parents, self).

The actual selection began with three cases which seemed especially fruitful in terms of my concerns:
I. Donald (assumed name, as are all others): male; age 40+; working class (WC) parents, middle class (MC) himself (having worked in money markets). The interview shows in particular: a sensitivity to differences in language between practices; and a range of feelings; see Ch.11 and also Evans (1988).

II. Ellen: female; age 18-20 at entry; MC parents. The interview shows: much expression of confidence, and a "surprising slip"; see Ch.11 and also Evans (1991a).

III. Fiona: female; age 25+; MC parents, MC herself (several jobs). The interview shows "mock-anxiety", turning into a range of strong feelings about her father at Qu. 3; see Ch.11 and Evans and Tsatsaroni (1993).

Eventually, I decided I needed to include accounts of interviews with two further women and two more men:
IV. Harriet: female; age 25+; WC parents, MC herself (unqualified social worker). The interview shows: diffidence with maths turning into confidence through her work, and pleasure in using formulae.

V. Alan: male; age 20; MC parents. The interview displays: his claims of "no feelings about maths"; and the importance of positioning vis-a-vis money.

VI. Peter: male; age 20; MC parents. The interview shows: his diffidence about his understanding of school maths, related to his father's (and older brothers') attempting to "help" with homework.

VIII. Jean: female; age 18-20; WC parents. (NOTE 13) The interview shows: the multiple bases of "maths anxiety"; and the importance of positioning vis-a-vis money.

See Ch.11 for accounts of all seven case study interviews. Illustrations are produced from all 25 interviews as necessary in Ch.10.

9.5 Summary

The interviews were focussed on a set of themes, or what are called "foreshadowed problems" in the ethnographic tradition of research. They include:

(1) context understood in terms of positioning in practices;
(2) the inseparability of task and context;
(3) structural (gender, social class) differences in performance understandable as differences in positioning within practices;
(4) numerate cognition as specific to positioning;
(5) gender differences in expressed anxiety;
(6) other feelings expressed or exhibited;
(7) anxiety and other feelings as specific to positioning;
(8) the relationship between affect and cognition as specific to positioning.

My method of interviewing used insights from the ethnographic tradition (e.g. Hammersley and Atkinson, 1983), and from the psychoanalytic critique of traditional fieldwork (Hunt, 1989). It attempts to synthesise the approaches of life history and problem-solving interviews, through the use of "contexting questions" related to each problem. The aim was to study the student's thinking and affect in this context, as well as in earlier experiences with maths and numbers, in relation to his/her positioning in specific practices.

Twenty-five interviews were conducted in June of the academic years 1984-85 and 1985-86. The sample was based on a combination of probability and volunteer methods in the first year, and on a probability sample stratified for gender, age and parental occupation in the second. The interviews took place in my office and appear to have been largely successful in establishing a relaxed and productive atmosphere. In order to try to assess the likely contribution of the interview arrangements, as well as my ongoing social relations with the students, to the positioning of the student interviewees in specific practices, I produced a general reflexive account, as well as particular reflexive accounts for each interview.

For problem-solving performance, I considered as indicators not only correctness, but also methods and strategies of thinking. For anxiety, I also considered indicators not only for its expression, but also for those situations where it might be "exhibited" but not expressed.

Two types of analysis of the interviews were used. The cross-subject analyses aimed to produce summaries of results considered comparable across the sample of 25 subjects. The single-subject analyses aimed to produce detailed case studies (and shorter illustrations), based on the life-histories and accounts given by selected interviewees emphasising the webs of meaning linking practices, cognition and affect.

In Ch.10, the cross-subject analyses relevant to the first five themes are discussed. In Ch.11 the accounts of the case studies are discussed, with especial reference to the last three themes.

CHAPTER 10 : INTERVIEW RESULTS - CROSS-SUBJECT ANALYSES

> The approach [...] must refer to the specificities of the different practices in order to describe the different subject positions and the different power relations played out in them. It cannot simply speak of a subject's behaviour and attitudes or ascribe in advance the subject's position according to class or gender.
>
> (Henriques et al., 1984, p.117)

In this chapter, I consider the analyses which are relevant to the first five themes discussed in the previous chapter. The analyses reported are mostly cross-subject, supplemented by ilustrations when appropriate. In Sec. 10.1, I use the ideas on context developed in Chs. 7 and 8 to produce a new way of understanding context as positioning in discursive practices. In Sec. 10.2, I consider evidence which supports the idea of the inseparability of task and context. In Sec. 10.3, I take another look at gender differences in performance, understood now not as resulting from differences in "essence" between males and females, nor as "internalisations" of earlier socialisation, but as differences in positioning within practices. In Sec. 10.4, I consider the results from several problems in the interview which support the idea that numerate cognition is specific to the context (understood as above). Finally, in Sec. 10.5, I reconsider gender differences in anxiety, expressed or "exhibited" (but unexpressed).

10.1 Theme 1: Context Understood in terms of Positioning in Practices

10.1.1. Review of theoretical issues

At the end of Ch.8, I addressed the question of what can be said about a subject's positioning, in specific discursive practice(s), in a situation such as one of my interviews. I argued that this entails several questions:
(1) What are the specific discourses available to position subjects in this particular situation?
(2) What determines the subject's positioning at any point?
(3) What indicators are there for the subject's positioning?
In response to these questions, my analysis is as follows.

(1) In the interview situation, each subject was positioned as a student on the BA Social Science degree course at the Polytechnic. From the "general reflexive account" (see sec. 9.3.3), it will be remembered that all of these subjects would have known me in a number of capacities, which positioned me as a teacher, as an authority, especially in mathematics, and as regulative of them in their studies in the institution.

At the same time, a student's basis for attending the interview itself was that s/he had been "chosen" (in most cases) in a random sampling exercise (see sec. 9.3.1), and had received a letter of invitation from me subsequently. The letter, and the script used by me as interviewer, were careful to talk about "research" and "interview" and "numbers", rather than "mathematics" or "test"; see APPENDIX I3 for the invitation to interview and APPENDIX I1 for the interview script, relevant parts of which are quoted and discussed in APPENDIX I5.

Thus, the two discourses which provide the overt possibilities for the positioning of the subject in the interview setting are:
academic maths (AM), i.e. college maths (CM), or school maths (SM) with subject-positions teacher / student; and

research interviewing (RI), with subject-positions researcher / interviewee. (NOTE 1)

(2) In the summary of Ch.8, I concluded that the subject's positioning depended on the interplay of a number of factors, including:

- social differences in, say, class or gender terms;
- language and the discursive features of the situation; and
- the subject's "investments of desire" (including the operation of defences).

Here I would argue that the subject's positioning at any moment in the interview will be what might be called a "resultant" of the way he/she is positioned in the interview, and of the discourse(s) called up in response to any particular task or problem. The subject will generally be multiply positioned in some "mix" of the two discourses, academic maths and research interviewing. And the resultant positioning may be fluid and changing. Hence the task is to describe this positioning at crucial points of the interview, rather than to attempt to describe some "overall" positioning for each subject. Indeed, through the way I defined the interview, in the invitation and in the script (see above), I attempted to shift the discourse and the positioning from having to do with academic maths, to that of a research interview.

What I am calling the research interview discourse can be considered to offer a space for other discourses to be called up, in a way that the academic maths discourses might not do. To the extent that a practice is called up other than AM, the subject will have access to ideas, methods of reasoning, "skills", and emotions from that practice. One aim of the interview, then, was, as much as possible, to create a situation with space for the subject to call up one or more discourses that would be called up if the subject were to be confronted with the problem in the course of his/her "everyday life".

(3) Concerning indicators for the subject's positioning,

Walkerdine has shown how to use indicators for determining what sort of discourse is in play, for a particular task in a particular context (1988, pp.53ff). She suggests attention to:

(a) the explicit form of the tasks, in their "discursive features", viz. the terms and constructions used; in my research, this would require examining how the interview itself was described (see above), and how each task or problem was introduced, in the interview script;

(b) the unscripted aspects of interaction between researcher and subjects: e.g. the (conscious or unconscious) emission of different verbal or vocal signs for "correct" and "incorrect" answers; and

(c) comments and responses given by the student both during the problem-solving phase of the interview, and afterwards: e.g. the language used in discussing the problems.

In addition, my social relations with the students in each year as a group, and with each individual student, had a "history", which preceded their receiving the invitation to interview. Also, the social / physical space that was the setting for the interview provides further information concerning positioning. Therefore I would add the following to the list of sources of indicators:

(d) reflexive accounts: e.g. the ways in which I had been in the position of "maths teacher", or "researcher", or otherwise related, to each of the subjects; see the "general reflexive account" given in Ch.9, and the refexive account for particular subjects given in Ch.11; and

(e) the setting of interview - its location in my office at college, the arangement of furniture, the use of a tape-recorder and where it was placed, the inability to intercept telephone calls or callers at my door, etc.

Concerning (a), it is noteworthy that the interviewee would possibly have been positioned in contradictory ways by the problem solving parts of the interview. First, unlike most such interviews, each problem was introduced by one of the two "contexting" questions, which asked specifically "which of your current activities it [i.e. the problem] reminds you of" (the "current" (C) contexting question); and the discussion on the problem was rounded off by the other: "which of your earlier experiences it reminds you of" (the "recall" (R) contexting question). These two questions, especially R, often brought up much life history material, and would tend to position the subject in what I call the research interview (RI) discourse. However, the numerate problem itself also included a "pseudo-question", as used in pedagogic or testing discourses, in that I "knew the answer" (or at least, I thought I did, at the start of the interviewing). This might tend to position the subject in what I call the academic maths discourse. This dilemma will need to be assessed in relation to particular problems for particular subjects.

In relation to (b), I aimed to minimise the potential problems from unscripted talk on my part, by having a standard response, intended as "neutral", to the subject's giving of an "answer" - namely, "fine, thank you"; see APPENDIX I1. This was because I did not want to allow the interview to drift into an academic maths discourse, as I judged it would, if we discussed answers before the end of the interview.

Concerning (c), the student's talk, the language used in discussing the problems was a crucial indicator of their positionings. Also informative were the "confessions" produced by several at the end, as to what they had thought they were going to have to do at the interview; see e.g. the transcripts for the selected interviews (in APPENDICES S1 to S7).

Sometimes it will be relatively straightforward to make a judgement as to the subject's positioning at a particular point in the interview. Sometimes it is not at all easy to decide. One of the features of the interview strategy that I used was that the contexting questions (C) and (R) - see above - seemed to recall several practices for some subjects. A number of examples, including several of interdiscursive positioning, will be given in the cross-subject analyses of the first six interview problems in this Chapter.

10.1.2 Positioning in the interview: problem 1

In order to illustrate the ideas of positioning in practices, I begin by showing how I made the relevant judgements for the first problem, Qu. 1 in the interview. This question presented a "pie chart showing water consumption" and asked

> [1] Looking at this 'pie' chart, which do you think uses more water - households or industry with meters?

(See APPENDIX I2 for the interview problems in full.) This problem was intended as a relatively easy "ice-breaker", and indeed 21 of the 25 subjects produced the correct answer. Two subjects gave what I considered to be "incorrect" answers, because of their positioning (see below). (NOTE 2)

The response of Peter (no.19 - see Ch.11 for case study and APPENDIX S7 for the transcript), illustrates how occasionally one can be exceedingly <u>difficult to classify</u> as "correct" or "wrong". He switches his answer from "households" (correct) to "industry, because of the metered and unmetered" (not answering the question), and back to "households" when I reread the question to him. I coded this as "correct".

Although problem 1 seemed easy for most subjects, for a researcher, judging the subjects' positioning was perhaps more difficult than for other problems - since the subject was likely to decide on the answer without producing much talk that could be used as an indicator (see (3) (c) in the previous subsection). Academic Maths appeared to be called up in most cases (at least 13 out of the 21 where I considered a judgement could be made). In some cases, for example with Jean (no.3), this seemed straightforward:

S: Well, it reminds us of when I first went into the comprehensive school, and you were given certain tasks to see which Set they wanted to allocate you to - and concerning Maths, there was a lot of those kind of charts....

(transcript, p.4)

(The transcript for this and the other six case study interviews are in APPENDICES S1 to S7.) Sometimes academic maths was called up in conjunction with another academic subject. For example, in response to contexting question C, no.20 first mentioned economics, a subject which she had just started to study at the Polytechnic, and about which she seemed to be somewhat anxious - and after giving her answer, mentioned RSA Numeracy, a subject she had studied at FE college.

No.21 (previously a manager) mentioned both statistical analysis in psychology (her chosen specialism), and data presentation and training exercises in management - though her dwelling on the meaning of the division of the pie led me to think that she was addressing the problem from within - i.e. had called up - a discourse like finance or business, rather than college maths or statistics.

The response of Harriet (no.16), an intending social worker and another one of the case studies (see Ch.11), was more complex. She called up an essay she was currently doing, because the pie chart reminded her of a "chart" in the relevant article showing a breakdown of types of poverty. She was also reminded of the dials on the electricity meter which are each marked from 0 to 9, pictures of which are shown on certain electricity bills. After answering the problem, in response to contexting question "R" - "Does this remind you of anything you've done in your earlier experiences?" - she added: "... [4 sec.] uh, back at school again, using a similar chart like that, you know, for a similar question...." (transcript, p.6).

Here, her mentioning academic maths, especially only after giving her answer to the problem, does not mean that she had <u>called</u> it <u>up</u> in order to respond to the problem. Also, though the action of reading dials on an electricity meter was also called up, it seems unlikely that the ideas, relations and variations associated with this - for example, the <u>equal</u> distances between marks on each dial - would help with reading a pie chart representing <u>unequal</u> shares such as that presented in Qu.1. Thus, in this case, I would conclude that Harriet's positioning was at least largely in a discourse other than academic maths, a discourse that involved the reading of numerate or quantitative information (NOTE 3); this conclusion is tentative, given the limited amount of information available.

An interesting example involving home practices is provided by no.6. The first thing she called up was exams in CSE Maths, which was "hard" because "you've got to use a protactor". Then,

> JE: ... does anything else come up around that question?
> S: ... no, apart from - this may sound silly, but - a cake divided into bits....
> JE: [...] is that something you do very often?
> S: No.
> JE: Uh huh [3 lines] ... was that a big thing about dividing the cake up equally?
> S: Yes, yeah. Still is.... [laughs]
> JE: [...] and who usually does the dividing up?
> S: Oh, that depends - 'cause my brother doesn't like me cutting it, 'cause he reckons I don't do them equal ... used to get Mum to do it....
>
> (transcript, pp.3-4)

Here she also called up home discourses, to do with sharing out "bits" of food treats, which seem to have been rare; also, her cutting of the cake was liable to provoke friction with one of her brothers about whether she was "doing them equal". This recalls Nick Taylor's descriptions of the powerful positive affective charge called up for some by the "bread metaphor" in his test and interview questions. Here, the cake metaphor was not presented as part of the pie-chart, but was called up by the subject herself. Further, its affective charge was at best mixed, because of the unpleasantness with her brother. Nevertheless, she got the question right.

Thus, given that she seems to have called up school maths <u>and</u> sharing food treats at home, we might call her positioning <u>multi-discursive</u> or <u>interdiscursive</u>. (NOTE 4) In being alert to a possible "intersection" of these two discourses, is it possible that the "difficulty" and unpleasantness from the friction around sharing "equally" at home might have been displaced onto the imperative to use a protractor to cut out "equal" sectors of the pie chart at school?

This brings us to the two subjects who, because of their positioning, gave answers I read as "incorrect". No.18 called up school geography, and Fiona (no.5) called up what was purportedly "general knowledge" (see Ch.11 for Fiona's case study). Both got the question wrong because they called up discourses which did not require them to <u>read</u> the pie chart - but rather allowed them to bring in "outside information" from the other discourse. Thus each could be said to "refuse the terms" of the question. For Fiona, however, bringing in ideas about defences from psychoanalysis allows a somewhat deeper interpretation in the context of her whole case study. This alerts us to the provisional character of many of the judgements made in this subsection, and in the analysis of the interviews overall.

To sum up, what seemed like a straightforward problem elicited a variety of responses. And subjects were positioned in richly differing ways. Some positionings seemed to be solely in academic maths, others largely in work practices. Others were apparently multiply positioned - in maths and another academic subject, in maths and work practices. (In some cases, it was not possible to say.) Further, some of the practices called up seem to bring an affective charge, e.g. of anxiety related to another of the student's current courses, or of difficulty and unpleasantness associated with sibling rivalry at home.

10.2 Theme 2: The Inseparability of Task and Context

This section aims to explore, using interview data, what were called in Ch.7 the traditional, utilitarian and alternative views of the relationship of cognition and context. These relate to the N0, N1 and N2 views of numeracy, respectively. In Sec. 9.1, I argued that the traditional view would expect a subject to think about problems with "the same mathematical content" in the same way. I argued that the utilitarian view would expect a different approach to problems based in differently described contexts - e.g. school maths (SM) or alternatively "practical maths" (PM). (It should be remembered that "PM" is shorthand for "practices other than SM, which have numerate elements".) The alternative view would agree with the utilitarian in stressing the importance of context - but it would see context as depending on the practices positioning subjects, rather than than just on the wording of the problem.

Now, my data may provide support for certain of these views, rather than others. First, the utilitarian and alternative views will be supported over the traditional, if the two problems in the interview involving the calculation of 10% - the abstract Qu.2 [10% of 6.65] and the "practical" Qu.4 [a 10% tip on a meal costing between £2.50 and £4] - were to attract different sorts of approach, i.e. to call up different discursive practices - in many cases, at least. Second, the alternative view will be supported over the utilitarian and the traditional, if the 10% tipping problem on the questionnaire (Qu.18) were to call up different practices (or to lead to the different sorts of answer) than the 10% tipping problem on the interview (Qu.4) - in most cases, at least.

There are methodological issues that come up when we envisage doing this. First, there is not a great deal of information available for making judgements about positioning - especially for Qu.18 in the questionnaire. For this question, indicators for being positioned predominantly in SM would be either doing a written calculation, or giving an answer like "37.2p" - which would not make sense within a tipping practice (or indeed within most money-based practices). However, since some respondents may have done written calculations for Qu. 18 but not have handed them in with the questionnaire, the absence of written calculations does not necessarily mean that the respondent was positioned in a discourse other than school maths. Therefore the numbers classified in "practical maths" for Qu.18 in the questionnaire must be regarded as strictly an upper bound.

Second, I have argued that in general a particular subject, confronting a particular problem in the interview, is positioned interdiscursively - in some "mix" of academic maths, research interviewing and perhaps some other "everyday" practice - rather than in a single practice. However, for this analysis, I had to try to record the practice which predominated in each subject's positioning, if possible. Third, though we can specify indicators for being positioned in school maths or alternatively in "practical maths", they may not be valid for every subject. Thus, for Qus. 2 and 4 of the interview, the indicators for being positioned predominantly in SM would be include doing a written calculation (see below). However, a subject such as Peter (interviewee no.19), even when (I would argue) he is positioned in SM, does as many calculations as possible mentally; see the discussion of his case study in Ch. 11.

In analysing this data, then, let us begin by seeing whether an abstract 10% calculation problem, Qu.2 on the interview, tends to call up the same discursive practice as the 10% tipping problem, Qu.4. An indicator for a predominant SM positioning can be, for either question the use of written calculations, or for Qu.2 expressed confusion as to where to put the decimal point, or for Qu.4, the giving of an answer which involved a fraction of 1p (other than the 1/2p, which was just being phased out in 1985 and 1986, when the interviews were done). For the tabulated results, see Table 10.1(p.456).

Here, the two questions describe a different situation, and therefore have a different "context" in the utilitarian and "alternative" senses - although, from the traditional point of view at least, both questions "are" percentage questions. The results show that, allowing for difficulty in coding the the subject's "predominant" positioning, 12 of the 23 subjects are classified in Table 10.1 as positioned in different practices for the two problems (see APPENDIX U3 and Sec. 10.4 for further on coding Qus. 2 and 4 respectively). All of these are coded as being positioned in SM for Qu.2, and in PM, tipping practices, in Qu.4; they include Fiona, Alan and Peter whose case studies are discussed in more detail in Ch.11.

Of the five coded in SM for both questions, only Jean is straightforward, because of "setting up" both calculations as a formula involving the multiplication of fractions. No.15, too, was classed as calling up SM for both questions, since she used laborious written methods for both questions (though she gave her answer to the "abstract" Qu.2 in money terms). Two other subjects, Harriet and no.11 (both working class subjects), gave "quick mental" answers to Qu.2 in money terms, and were classified with up to four others as positioned in "PM" for both questions.

Overall, then, because of the "disparity" in positioning for the two questions for many subjects, we can conclude that positioning is not based simply on the arithmetical or mathematical qualities of the question.

Next, let us see whether a 10% tipping problem on the questionnaire (Qu.18) tends to call up the same discursive practice as the 10% tipping problem on the interview (Qu.4). To do this we can again attempt to assess the predominant positioning of each subject for each question, using as indicator for a SM positioning in each case _either_ the use of written calculations _or_ the giving of an answer which involved a fraction of 1p (other than the 1/2p). The tabulated results are as in Table 10.2.

Now, if the context of the task were completely specified by the situation described by the wording of the problem, then we would expect all, or almost all, cases to be on the main diagonal of the table. As it is, almost half (9 of 20) of the cases as coded are _off_ the main diagonal. (NOTE 5) Thus there is support here for the idea that there is more to the context than simply the wording of the problem, or the representation of the situation in language.

These two analyses recall Taylor's (1990a) work (see sec. 8.4.2). He calls the shift in "subject-position" - or in my terms, "positioning" - between written test / questionnaire and interview contexts an "interdiscursive" shift, and the shift in positioning made by subjects with respect to different embodiments ("bread" and "cake") an "interitem" shift. This distinction is _broadly_ parallel to the different aims of the analyses related to Tables 10.2 and 10.1, respectively. (NOTE 6)

The main conclusion from my Table 10.1 (as well as from Taylor's interitem analysis) is that the practice called up is not fixed according to the arithmetic or mathematical qualities of the problem. The main conclusion from Table 10.2 is that the situation described in the problem does not fully specify the context of the problem.

10.3 _Theme 3: Gender Differences in Performance Understood as Differences in Positioning within Practices_

In order to consider any apparent gender differences in performance in the interview, and whether they might be illuminated by differences in positioning, I examine the results of problem 3. Similar issues are raised by the analysis of problem 2; see APPENDIX U3.

Problem 3 referred to a graph entitled "The London Gold Price - January 23rd 1980" and read

> This graph shows how the price of gold varied in one day's trading in London. Which part of the graph shows where the price was rising fastest? [called Qu. 3A]
> What was the lowest price that day? [called Qu. 3B]

(See APPENDIX I2 for the interview problems in full.) It will be noted that Qu.3A required the subject to choose one of the two parts of the graph where the price is "rising". (Thus, a student could guess with a 50% chance of being "correct".) Qu.3B required the subject to read (the ordinate for) a point on the graph.

For this question, subjects' performance was surprisingly error-prone. There were several "characteristic errors" to be expected. For part A, the error (made by 7 of 23) involved choosing the "afternoon" price change as the fastest rise, perhaps on the mistaken reasoning that "fastest rise" means "rising to the highest point". (There is a parallel mistake in reasoning that "fastest rise" means "rising from the lowest point", which yields a "correct" answer; e.g. no.23's response might be read as using this reasoning.) It is interesting that this part of the question was done only "by eye", rather than by calculating both slopes, by all except for Donald (NOTE 8).

For part B, the error (made by 9 of 23) was in misreading the point which was two subdivisions below 600 as "580", rather than 590. Here it might be argued that some of these errors were precipitated by my using a slightly imperfect photocopy (again see APPENDIX I2), and this might be supported by the fact that two students read the point as "585". However, there are other possible interpretations (see below). Overall, only 11 of 23 students were classified as correct on both parts of the question.

Table 10.4 shows the results for Qu. 3, where the subjects' performances are cross-classified by gender and qualification in maths. (A cross-classification of performance by gender and parental social class is not included, since there were no perceptible social class differences.) The Table also classifies performance according to judgments made of the subject's "predominant" positioning. Eighteen of the 22 subjects who were classified here were judged to have called up school maths or college maths, sometimes along with another academic subject currently or previously taken; thus, Peter called up Economics, his chosen specialism at the Polytechnic (see his case study in Ch.11). Alan was classed as calling up school maths - despite his being one of the few subjects to give his answer in the relevant units ($ per ounce) - in the light of his response to contexting question (C):

> JE: Right does that remind you of anything? ... anything you do these days?
> S: Not particularly, no - I wouldn't use that, wouldn't look at it, wouldn't be interested in it, unless I was interested in gold [laughs] ....
>
> (interview transcript, p.5)

(See also Alan's case study in Ch.11.)

In contrast, interviewee no.21, previously a manager, could not "recall anything specific" for contexting question (C). But when thinking about Part B ["the lowest price that day"], she asked "Do you want me to be specific?" I take this to be a question, from within a business discourse, about how much precision is needed in the actual context. Perhaps this also suggests that, for many business contexts, not a great deal of precision would be necessary. This is confirmed when, for (R):

> JE: ... Does that remind you of earlier experiences?
> S: Well, I'll answer again [i.e. as for Qu.2], when I was working, we would use these graphs, but not so much: we just had wall charts to show levels of business [..] from the previous financial year and that

was about it....

(interview transcript, pp.7-8)

I therefore classed this subject as having called up business maths (PM).

Moving on to discuss performance differences, it can be seen from Table 10.4 that there appear to be gender differences, but that these vanish for high-qualified students, though not for low-qualified. (This is also so with problem 2; see APPENDIX U3.) Again caution is in order because of the small numbers. Further when we consider the performances of those whose predominant positioning was SM, we find that the differences related to qualifications in school maths remain: of the 7 high-qualified (i.e. with O- or A-level), 5 answered both part A and part B of the question "correctly". On the other hand, only 5 of the 11 who had "low" qualifications in SM answered both parts correctly.

There are a number of "surprising errors" made. Among the "high" qualified, no.4 (Keith) is reminded by this question of calculus in A-level maths, which "confused" him, and he gets part A of the question wrong, that concerned with picking out the larger of two "gradients" (see his "illustration" in APPENDIX U2). Also, as discussed above, the characteristic error for Part B [misreading the lowest price as "580" or "585" instead of 590], was made by 9 students out of 23. (NOTE 8a)

Four of those who misread the graph for Part B were classed as calling up "money maths" or "business maths". Indeed, <u>all</u> four students with that positioning made that error! This was all the more surprising, as three of the four - Donald (previously in the money markets), no.9 (previously a stockbroker) and no.21 (the woman manager), all had extensive work experience with graphs such as these, as well as recognising them from SM or college maths! Part of the explanation may be that in the money and business practices within which a few subjects were positioned, readings of graphs are regulated differently, since they are made for different purposes - e.g. for broad comparisons, rather than for precise individual readings. (Further research may clarify this.)

The fourth subject classed as calling up money maths, Fiona (a stockbroker's daughter), not only made the characteristic error for part B, but also got part A wrong. She seemed unsettled not to find the times of the opening and closing of the market along the horizontal axis, and she went on to "refuse the terms" of the question, and to purport to answer on the basis of outside knowledge: "my father's a stockbroker, so therefore I do understand a little about opening and closing" (transcript, p.8) - as she did for question 1 also (see Sec. 10.1). Here, it appears that she experienced a great deal of emotion, e.g. frustration and anger, in confronting the question; see the later discussion of her case study, especially the affective aspects, in Ch.11.

To sum up, when we consider "correct" performance for Qu.3, there initially appear to be gender differences, but these are partly explained by differences in qualification in maths - for the high-qualified (O-/A-level) only. That is, there still appears to be a lower level of performance among low-qualified women students. However, this relation of performance to gender and qualification differences appears to hold only for those positioned in academic maths - but not for those few who were judged to have called up various business practices, etc. within which to address the problem (though the numbers are very small). Thus we see that gender differences in performance may depend, at least to some extent, on the subjects' positioning in practices. (These conclusions are very similar to those for Qu.2; see APPENDIX U3.)

10.4 Theme 4: Numerate Cognition as Specific to Positioning

(a) Problem 4

In retrospect, it can be seen that this problem marked a change as the interview progressed, to more practically-based questions. Perhaps this was because the sheet presented to the subject showed only a facsimile of a restaurant menu, with no written question added, or perhaps it was because the problem was introduced by reading out several contexting questions in turn - CA, CB and A:

> [Show the "menu".] (CA) Do you ever go to a restaurant with a menu anything like this? ...
> (CB) Would you please choose a dish from this menu? ...
> (A) Suppose the amount of "service" that you leave is up to the customer: what would you do ? ...
> (B) Could you tell me what a 10% service charge would be? ...
> (R) Does this remind you of any earlier experiences?

(See APPENDICES I1 and I2 for the full version.) In contrast, Brigid Sewell (1981)'s problem using the same menu had included only questions CB and B.

For my problem, the interest centres on:
- how the subject handled the simulated tipping situation, including any rules or conventions enunciated to govern tipping in question A;
- their positioning when responding to B;
- the method of calculation used for B; and
- the correctness of answers to B, in the light of the last two issues.

For question CA, 21 of the 22 subjects asked reported eating out. The exception was Peter, who responded: "No I mainly stand outside - I don't go in" (interview transcript, p.17; see also Ch.11). Five others indicated that they did not do so often, e.g. no.24 ("not for ages"), for whom nevertheless "eating out" had very pleasurable associations - as it did for Harriet (see Ch.11). Eight others were not very attracted to dishes on the menu - on the grounds that they were vegetarians (five, including Donald), or that the menu was not sufficiently "special" (Fiona). In response to the vegetarians, two dishes (and prices) were constructed: a Three-Bean Salad at £2.53, and in one case, a Stuffed Baked Potato at £1.13.

For A, subjects displayed several ways of handling the tip / service, with the following frequencies (out of 23):

- using a general percentage:	10%	6
	15% or 1/6	2
- giving a specific amount: 50p or £1 or £1.50		3
- rounding up to the nearest "coin", 50p, etc.		10
- no tip		2

In many cases, rules or conventions were mentioned by subjects as governing this; in other less clearcut cases, the rules were inferred. For example, one of the "non-tippers", Donald, said only that he would not give a tip on a jacket potato costing £1.13. The other, no.4 (Keith), "enunciated" a rule "10%, and round up if it's small", but it seemed that he really had a preference not to leave a tip at all, and that he used to have rows with his ex-girlfriend about the issue (transcript, p.7). (NOTE 9)

It would appear that the contexting questions CA, CB, and A were basically sucessful in leading subjects to call up practices around "eating out", as at least part of their positioning. When we move on to question B, there was a generally higher level of performance - 19 correct out of 23 - than on the other "ten percent of" question, the "abstract" Qu.2 - 15 out of 23. The improvement came especially among those of mixed or undetermined parental social class who had had rather more difficulty with Qu.2. Some gender differences remained (91% correct for men and 75% for women), but these were much smaller than for Qu.2. Thus, it seemed worthwhile checking whether performance was related to positioning, and to the procedure for tipping enunciated in response to A, as well as to gender; see Table 10.5.

For part B, I judged that at least 5 subjects were positioned, at least "predominantly", in academic (school / college) maths (see also Sec. 10.2). For example, no.21, a former manager who was unenthusiastic about this menu, gave an answer that would have been "inappropriate" in the eating out discourse - namely "25.3p", but "corrected" it to "20p" when prompted. (NOTE 9a)

Subject no.9 again provides an example of the difficulty of judging positioning for this question. His tipping rule was 10% (conditional), and his tip was calculated immediately. When I asked him how he had calculated it, he produced a "decomposition", as he had done for Qu.2. (NOTE 7). The use of decomposition might confirm his positioning as in a non-school practice (NOTE 10) - or he might have been displaying "proper" arithmetic for the interviewer, as other subjects also seemed to do. (NOTE 11)

It is also difficult to classify one or two of the responses as "correct" or not. Interviewee no.17 (a young black male) was one of the three subjects who specified an amount in their response to question A: in his case, on £3.75, "you can't go lower than 50p, so I'd probably give 'em a pound". Then when I pose B "Supposing it says at the bottom 'service charge 10%' ... ?", he says "75p" (pp.15-16 of transcript). This may be because he doesn't understand very well what I am asking: the term "service" was not well inderstood by several subjects. <u>Or</u> it may be because he has a faulty algorithm for calculating 10%, viz. "take the <u>last two</u> figures". (His answer ".65" to Qu.2 [10% of 6.65?] certainly allows this interpretation to be supported.) <u>Or</u> it may be because he is positioned at an intersection of eating out (practical maths) and interviewing / testing, and hence seeks to produce some sort of <u>compromise</u> answer: otherwise, he would have to <u>suppress</u> his sense of what was proper in <u>tipping</u> practices in order to calculate a precise 10% of £3.75 for the interview question. My decision was to code his response to B as "wrong" in Table 10.5, but this judgement must be seen as tentative and based on a reading of the data which is not complete. Another case, that of no.24 (an older black female), seems very similar. (NOTES 12, 13)

I return to the gender differences in performance - 10 of 11 correct for men and 9 of 12 for women - which are very small. Nevertheless, differences in positioning may help to explain these, and they are interesting in themselves: all 11 men were classed as calling up eating out for this part of the question, whereas 5 of the 12 women were classed as positioned in academic maths. And only 3 of 5 calling up SM got the question correct as compared with 16 of 18 calling up eating out.

We can also attempt to assess the importance of familiarity in subjects' ability to calculate a 10% tip. If we consider the 6 subjects (out of 23) whose positioning is predominantly in eating out and who claim to use a percentage rule for tipping, we would expect them to perform relatively well, and indeed all 6 of 6 got the question eventually correct. Indeed, the only errors in calculating 10% are among those who call up eating out and who claim to tip a specific amount (2 of 3 incorrect), and among those calling up SM (2 of 5 incorrect). Though the difference between the first group and the others is small, it gives some support to the idea that familiarity with an operation facilitates use of that operation. (The idea of familiarity is further discussed in Ch.11.)

To sum up, there were small gender differences in performance (correctness) for Qu.4B [10% tip on menu], but these appear to be explainable in terms of the "predominant" positionings of the subjects. There is also at least some support for the idea that familiarity within discourses of eating out with a "rule" for tipping which is "similar" to that required for solving the problem, is related to correct completion of that task.

(b) Problem 5

The full set of questions posed for this problem were:

> (C) Have you ever received a slip like this?
> [5] [displaying a copy of a payslip] <u>Wage Rise</u>
> Jennifer is expecting a rise of 9% on her gross pay.
> (A) About how much will that be?
> (B) (If (A) is answered) can you work it out exactly?
> (R) Does this remind you of any earlier experiences?

(See APPENDICES I1 and I2.) Contexting question C was read as the written problem, including payslip and questions A and B, was presented to the subject; contexting question R was posed afterwards.

This problem is fairly complex. In order to produce a solution, it requires the subject to follow several steps. In most cases, these were:
(i) extract the correct information about gross (e.g. rather than net) pay, and incidentally to choose between "gross pay to date" and "gross pay this period";
(ii) decide on an appropriate way of modelling / calculating "about 9%", as say "about 10%" - or "10% minus a bit" - or "10% minus 1%";
(iii) do the approximate calculation, including the use of estimations as appropriate;
(iv) do the exact calculation, including (as in all such) remembering the required percentage and the specified amount, setting the operations up the right way (viz. 9/100 x the amount), completing the arithmetic operation (i.e. multiplying) corectly, and putting the decimal point in the right place.

Several "characteristic errors" are possible for this problem, related to each of the steps set out above:
(i) extracting information about net (rather than gross) pay (extracting "gross pay to date" was not considered an error);

(ii) / (iii) deducting rather too much from £8.65, to give an answer of £4 or £5; such an answer was classed as "approximate" only;

(iva) setting up the exact operations wrongly; e.g as 100/9 x ...

(ivb) making a calculation error or slip;

(ivc) locating the decimal point in the wrong place.

At each stage, we might note whether the subject evaluates his/her thinking critically (see examples below) and possibly corrects a slip. I also noted whether the subject used written methods for the exact calculation - to set up the calculation required, or actually to perform the crucial operation. For the results, classified by gender and positioning, for parts A and B, see Table 10.6.

Considering positioning for part A of the question, most subjects called up reading payslips in various contexts: almost all subjects had had paid work, and had been paid using such a payslip, though many mentioned that it was less complex than the slip shown in Qu.5. Here the indicators for calling up discourses related to paid employment were doing the calculation in one's head and giving an approximate answer, i.e. to the nearest pound. Thus, no.18 (a young male), who gave an answer of "62p" (i.e. about 0.9%) for this part of the problem, was classed, exceptionally, as calling up school maths for part A, as well as for part B.

An illustration of the powerful affective charge that discourses related to paid employment may have is given by interviewee no.2's most clear articulation of the sort of "cash nexus" relationship that an unskilled manual worker has with his or her work:

> S: ... we'd have a period when they'd got a new wages girl, and she was not too hot - it wasn't so much the working out, it was, like, losing [laughs ruefully] your overtime pay on the wage slip.... [JE: 2 lines]... I think most people [...] used to go over their wages paid - you had to ! ... [6 lines] ...
> ... like, the only reason you work in a factory - you

don't like it, working in a factory - you're only there for the money, aren't you? If they aren't getting paid for the hours, most people get very irate, and if you're coming off night shift, and you have to go up and sort it out with them....

(interview transcript, p.7; his emphasis)

The subject's emphasis on certain words exhibits his feelings of frustration and anger, which the later use of the term "irate" confirms.

However, for part B, most of the subjects - up to 12 of the 17 attempting the question - were coded as having called up school maths; of those classed as calling up "practical maths" (i.e. practices related to paid employment), all five used <u>written</u> methods. Here, using written methods does <u>not</u> necessarily indicate that the subject has called up school maths. For example, no.13 (25+, a former electrician) makes a most creative approximation: 9% of £1335.45 = 9 x £13 (NOTE 14), then writes it down in order to do the multiplication only, apparently as a <u>memory-aid</u>, for doing the calculation. This could indicate a positioning in school maths - or it might well indicate practical maths, since we would not expect <u>all</u> calculations within PM to be done mentally. (Or it might indicate an interdiscursive positioning, examples of which will be discussed in Ch.11.) Using pencil and paper - or indeed a calculator - to <u>do</u> a calculation must be distinguished from writing it down in order to <u>set up</u> the original fraction, as in: 9/100 x £1335. Writing down at the original "setting up" stage would be a clearer indication of a positioning in school maths.

For performance results, again see Table 10.6. For part A, 9 of 17 subjects produced a "close" estimate (i.e. between £6 and £7), which rose to 14 out of 17 if "approximate" results (i.e. between £4 and £5) were allowed for. Two of the men and two women made <u>very</u> close estimates (viz. £6). For part B, however, only 5 of 17 produced a correct answer (viz. £5.99 - including no.2 with £5.88). Six more made errors to do with "setting up" the calculation (e.g. choosing division, rather than multiplication), in calculating, or in placing the decimal point, two of whom noticed (see below). (NOTE 15) Six more refused to go past a certain point in the problem. Thus there do not appear to be gender differences in performance, either in part A (about 50% "close", another 25% "approximate"), or in part B (about 30% correct).

However there do seem to be gender differences in positioning, and there do seem to be differences in performance related to ("predominant") positioning. Most strikingly, for part B, of those positioned in PM, 4 of 5 were coded as correct; for those calling up SM, only 1 in 12 was correct. And for part B, 8 of the 10 women were positioned in SM, as compared with only 4 of the 7 men.

Thus for this problem at least, we can begin to sketch an account of gender differences (though there were none apparent in the simple performance results). For part B, men were more likely than women to call up those practices - to do with paid work, wageslips, etc., - within which this problem might be seen as "practical". Further, those who called up practical maths thought the problem through to a correct answer more often than those in SM. And they had reason to find the problem "familiar", in terms of their previous (usually work) experience. (NOTE 16)

There is one aspect of performance in which there appear to be gender differences: five of the six who refused to pursue part B through to the end were women. As we have seen, the men's perseverance did not result in a higher level of correct performance, but they did produce more "answers" - even if some were clearly wrong, such as no.13's "£207" for 9% of £1335 (see above and NOTE 15), or no.18's "62p" for 9% of £66.56. It might appear that the men's "perseverance" was based on greater confidence - or perhaps greater "bluff" - whereas the women were diffident or anxious. I shall reconsider "confidence", "diffidence" and "anxiety", in Ch.11, using illustrations and case studies.

Those subjects who worked through to an answer, right or wrong, allow us to consider examples of critical _evaluation_ of one's own thinking. In one case, no.22 (the part-time accounts clerk) set up the calculation as 100/9 x 1335.45. That is, she sets up the inverse of the operation needed, but critically evaluates her answer, apparently from within a school maths perspective: "It looks too much" (interview transcript, p.14). (Also, her later answer is given without units and with four decimal places.) Elsewhere in the interview, she indicates that her approach was often "that very - sort of - trial and error method I used to find an answer tha looked reasonable" (transcript, p.7). No.22's error, and her basis for "noticing" it, were similar to the error and the evaluation made for Qu.4, by Ellen - except that Ellen did not appear to be using trial and error; see Ch.11. If, no.22 does not really understand the algorithm, as she claims, then critical evaluation of answers is _crucial_ to her approach!

One or two other subjects noticed errors, also. For example, no.1 (the industrial nurse) attempted to divide 9 into £49.80 (net pay), then noticed that that would give more than £4.98 - not less, as she expected, but she could not find what to do next. On the other hand, most of the other five subjects who made errors at various stages did not notice: for example, no.13 and no.18 (on part A, see above).

To sum up, despite the very small numbers and the simplification involved in coding "predominant" positioning, there appears to have been a higher level of correct performance for part B among those calling up activities related to payslips, etc., than among those calling up academic maths. These sorts of differences in positioning may help to explain what have sometimes appeared as gender differences. On the other hand, there did appear to be gender differences in that a much higher proportion of women refused to continue with the problem, whereas the men tended to persevere to produce an answer - although this did not produce a higher level of _correct_ answers. Some subjects were sufficiently critically reflective to notice an error - and in one case to correct it - but many others did not.

Further findings about the basis on which such critical evaluations are made would be valuable.

(c) Problem 6

The full set of questions related to this problem were:

> (CA) Do you ever go shopping for food? Where would you normally go?
> (CB) Do you ever buy ketchup (or jam, etc.) ?
> (CC) If you were buying ketchup or [other food mentioned] and several jars were available, how would you decide which one to buy?
> [6] [showing a picture of two bottles of tomato sauce, with prices and sizes, metric and Imperial marked] The larger bottle in this picture holds 30 oz. and costs 69p. The thinner bottle holds 20 oz. and costs 52p.
> (A) Which of these two bottles would you buy? Why?
> (B) Which is better value for money?
> (R) Does this remind you of any earlier experiences?

This sort of problem has already been researched by Capon & Kuhn (1979, 1982), and by Jean Lave (1988) et al.; see the literature review in sec. 7.4.3 above. Here, however, there was a relatively long sequence of "contexting" questions (three - CA, CB, and CC) - unlike Capon and Kuhn's work at least. (As well as using best-buy simulations, Lave et al. also conducted observation in the supermarket, and thus might have been able to draw on informal conversation recorded there and elsewhere.) Here the analysis will centre on the range of "strategies" used by the sample for question B, the practice(s) called up by the subject, and the way the first two relate to correct performance for question B.

Here, I will distinguish a <u>strategy</u> from a <u>method</u> or procedure. A method can be seen as broadly the same as the "operation" in Scribner's hierarchy of operation / action / activity. A strategy can be seen as higher-level thinking guiding the choice of methods or concepts to use (Bell et al. (1983, Ch.4); cf. Scribner et al.'s work in Sec.7.4).

The strategies used by my subjects on this one question were almost as varied as those found by Capon and Kuhn (C&K) and Lave et al. - despite the use of two problems by C&K and 12 by Lave et al. in their best-buy simulations. For the six "levels of reasoning strategy" used by Capon and Kuhn, see Table 7.1.

No one in my sample (n=14 by this stage of the interview) used a straightforward version of strategy (1) ("extraneous, task-extrinsic" reasoning) - but see Jean's case below. I did not consider (3) ("partial") to be a strategy, but rather a state arrived at, during the process of problem-solving, by several subjects, especially those using strategy (4) ("differencing"). Table 10.7(a) presents my results on strategies used, compared with earlier studies.

The "better buy" question in my interview was of a type called "price / quantity" ratio by Lave (see sec. 7.4.3(c)). Thus we would expect to have a fair level of use of strategy (5) ("price / quantity ratio comparison"), as indeed there was in Lave's simulation, and in the supermarket observation. Here, we have only one example - the solution of no.4 (Keith) who compared the cost of 60 oz. of ketchup, based on buying either (i) three 20 oz. bottles, or (ii) two 30 oz. bottles; we might call this the "lowest common denominator (LCD) of quantities" strategy. Though there are 29% (4 out of 14) unit price (6) solutions - comparable with the other two simulations, but more than the supermarket observation, the most frequent strategy used is differencing (4): it has about the same frequency as the use of strategies (4) and (5) in both Lave et al.'s simulation and supermarket studies. The other subject, Alan used strategy (2) ("extraneous, task-intrinsic"), in that he <u>assumed</u> that the bigger bottle would be the better buy, and therefore <u>guessed</u> an answer that happened to be correct (see below).

Thus my subjects used strategy (5) ("P/Q ratio") <u>less</u> that would be expected, and difference strategies (4) more than would be expected, in comparison with the other studies. Lave has given a convincing rationale for the use of difference strategies: they allow a decision to be made, based on actually-existing alternatives, and using a mixture of numerical and non-numerical criteria (see sec. 7.4.3 above). That is, they allow not only the "mathematical" qualities of the problem, but also various aspects of the context of shopping - cash to hand, carrying capacity, storage space available, etc., to be taken into account.

This leads to considering the practices called up by this question. I found that most subjects called up shopping, and it remained the "predominant" positioning of most, throughout the discussion of the problem. This was presumably because of the relatively long sequence of "contexting" questions (see above), because of the graphic nature of the picture of the two ketchup bottles, and because the practice is so familiar to most students and young people of this age group.

For example, Ellen called up shopping, and appeared to remain "in" shopping for the whole problem. As criteria for which jar to buy, she gives "best value for money" (interview transcript, p.10), and later "what I like to eat best" (p.11) and "better" quality (p.12). In response to question B, she takes 10 seconds to compare the two "unit price" ratios mentally - and approximately - i.e. using strategy (6), and gives the correct answer. No.23, also a young woman, who was being supported financially in her studies by her father in a Mediterranean country (and being "regulated" financially by her brother here), called up shopping, too, though it was somewhat painful because of her constrained finances. Her rules for choosing were that she should be familiar with the brand, and then she would take the larger size, providing it did not cost too much money. To question B, she responds almost immediately: "... the larger one" - and in response to my "Why?" - "It's only a difference of 17p, and you get 10 oz., and that should turn out more." (transcript, p.23) She does the calculation mentally and quickly: it is clearly one with which she is familiar. (NOTE 17) Her answer is coded strategy (4), and "correct / incomplete", since her reasoning has not been completely explicated, but she does not appear to be guessing (see further discussion of strategy (4) below.).

On the other hand, though Keith refers to shopping, he makes it clear that he does not do any best buy calculations in the supermarket: "It's just a matter of looking for the cheapest and assuming that ... you're making an economy with a larger packet ..." (interview transcript, pp.11-12). Therefore I concluded that, though initially calling up shopping practices, he was positioned largely in school maths when he produced his somewhat spectacular version of a strategy (5) solution (see above). The only other subject that I considered to call up school maths clearly for part B was no.9; see the discussion of his tendency to call up school maths at points of the interview where an exact calculation or rationale was requested in APPENDIX U3. Given his upper middle class positioning in purchasing practices, his general rule is to buy anything in bulk "simply because the value works out enormously better" (interview, p.15). When probed, he produces a calculation which appears to follow stategy (4), but he makes an error and is unclear about what he is doing, because the action is not familiar - perhaps because he does not ever really <u>have to</u> do best buy calculations in shopping. His response, though "correct", was classed as a "guess": he is probably using strategy (2), based on "large sizes are cheaper".

Two subjects showed they had called up <u>multiple</u> practices. Alan (see Ch.11) and no.13, a man, 25-plus. The latter, for part B, seemed to call up three practices - in which the meaning of the act of comparing the two jars of ketchup as to the "better buy" varied. When shopping for himself, it would be "a bit nit-picking to...work out the actual difference per ounce"; when taking a group from the youth club on an outing, you have "got to account, when you're using someone's money ... be tight on calculations" (p.17). On the other hand, if he had to answer something as a SM calculation, "I need to sit down and ..." (p.16). Nevertheless, in the interview, he was able to make a provisional decision that the larger bottle of ketchup was the best buy. Then, when I ask why, he produces very clear unit-price calculations (done in his head), but then claims that "it's quite close ... probably about the same" (p.16). This is perhaps because his approximation is too rough to allow him to distinguish - or perhaps he feels it is inconsequential; see his comments on "nit-picking" above. This answer was coded "correct" relative to his current positioning in (his own) shopping - though it might have been coded as an "inferential error" by Capon and Kuhn, and perhaps as a slip by Lave et al.; see Ch.7.

Since our earlier discussions of shopping practices (see sec. 7.4.3) and positioning (Sec.7.5) suggested the specificity of social class positioning in such practices, I now consider the relationship between positioning, strategy used and correct performance for part B; see Table 10.7(b). We might also note whether this sort of best buy calculation is an action with which they are familiar, within their everyday shopping activity.

As we discuss Table 10.7, it is especially important to note that the number of subjects responding is by Qu.6 in the interview very small (n=14); therefore, any conclusions proposed must be regarded as suggestive only. Social class differences were considered because of the relevance of practices related to the availability and spending of money, and to consumption generally (NOTE 18): there were suggestive differences only, pointing to a tendency of those from middle class homes to produce answers classed as "fully correct", while working class subjects tended to be coded as "correct, but incomplete" in displaying their numerate reasoning. Clearly, this difference, as well as being slight, relies on the extent to which I "probed" in the interview, and also on my coding judgements. It also recalls the point made above that strategy (4) differencing is based both on the numerate criteria of best buy "relative economy", but also on non-quantitative, contextual factors.

Therefore it is to be expected that responses produced using strategy (4) may appear "incomplete" from a mathematical perspective.

All five subjects using strategies (5) and (6) scored correct except for no.21, who made a slip in calculating one of the unit prices. (NOTE 19) All but no.13 are from middle class families (and he had been in a well-paid engineering job for some time); this recalls Walkerdine's point about certain kinds of calculation being enjoyed as a game within middle class families, but not within poorer families where resource constraints are often too painful to be suppressed (see Secs. 7.5 and 8.4).

Thus two women (from working class families) chose the wrong bottle. No.1 (ex-nurse), whose rule for choosing was "the right make, then I'd see which one was cheapest for which size", then chose "probably this one", i.e. the smaller. She went on to make a crucial approximation error:

> Dunno ... That's [the larger] got 10 more ounces, but it's a lot dearer, and - 70p is a lot of money, whereas 50p - nearly 50p - isn't so much .... [JE: Umm, umm] 70p is nearer a pound, 52p is nearer half a pound - in money [JE: Right, right] - so I wouldn't ... yeah ... I'd much rather the pound than the extra weight of ketchup....
>
> (interview transcript, p.11)

One explanation for this might be that she desperately wants to justify buying the smaller - and cheaper - bottle. (Another of course might simply be that she wants to rationalise a hasty or uncertain guess about the answer to this question.) No.3 (Jean) defected to what I classed as strategy (1): "the 17p price difference [is] more relevant" (transcript, p.11) - thus again displaying the practical constraint of limited resources, or absolute economy that is ignored by the "relative economy" assumptions and demands of the "mathematical" best-buy task.

Here both women choose the "wrong" bottle of tomato sauce, because they seem reluctant to tie up an additional amount of their money in a bigger bottle. This can be contrasted with no.7 (Alan), who buys "what I want" and refuses to get involved in best buy calculations when shopping with his parents' money, since it is not worth his time. This discussion suggests that these responses may be related to social class positioning. For more discussion of the effects on positioning of constraint and abundance, and especially of Jean's and Alan's cases, see Ch.11.

To sum up, my group of fourteen subjects, here doing only one best buy question, appeared to display as wide a range of strategies as were used by subjects in the Capon and Kuhn and the Lave studies (two and 12 questions respectively). Though my subjects used unit price strategy (6) (in Piagetian terms, the most generalisable) as often as subjects in the other best buy simulations, they used strategy (5) price / quantity ratio less, and strategy (4), differencing, much more.

In addition, I have shown through a number of illustrations that both the "strategies" used by subjects, and the answers given, can be shown to be specific to their positioning in practices. In particular, social class-specific positions are important in several ways. The relationship between middle class background and successful best buy reasoning supports the idea that the ability to reason in certain ways presupposes a position of relative freedom from constraint and anxiety from which to consider a range of alternatives. For those from more affluent backgrounds, this problem also raised the issue of whether a particular difference in price would be <u>evaluated</u> as being worth bothering about, for a particular subject.

10.5 Theme 5: Gender Differences in Expressed Anxiety

My original hypotheses were that (i) a higher proportion of women than men would <u>express</u> anxiety about something, during the interview; and (ii) men would tend instead to <u>exhibit</u> anxiety; see Sec.9.1. Therefore I classified each of my 25 subjects on whether or not they <u>expressed</u> anxiety at any point in the interview, and whether they appeared to <u>exhibit</u> it. (At this stage of the analysis, I made no attempt to judge the subject's positioning at that point of the interview.) It will be recalled that the signifiers considered to express anxiety included "anxious", "scared", "unsettled"; the indicators for exhibited anxiety included "Freudian" slips, denial, and behaving "strangely" or unusually. For discussion of the ideas behind the codings, see sec. 9.2.4; for illustrations, see below.

The results are summarised in Table 10.8. Twenty-two of the 25 subjects are coded as expressing anxiety <u>and</u> exhibiting anxiety, or as expressing anxiety <u>and possibly</u> exhibiting anxiety. To begin with, examples can be given from the two students who did not really complete an interview in the usual way. No.8, a 25+ working class man with no maths qualifications, came rushing into the interview at the agreed time, full of the "panic" he had felt the previous evening when he had been offered a job in a bar and then had felt overwhelmed by fear about how he would cope with the need to add up the cost of each order of drinks. Since he clearly needed space to discuss that, I dispensed with my interview script, and conducted what might be called a "free association" (see sec.9.2.3) or "co-counselling" interview with him. In Table 10.8, it can be seen that no.8 was coded EXP+, and also EXH- (?), since I was uncertain about the most likely indicator of exhibiting of anxiety: "I'm still quite shaky on it [college algebra] ... [2 lines] ... I don't let it scare me....." (interview transcript, p.16).

Another student did not complete a normal interview - no.25, a woman 21-24 of "mixed" social class. Although having agreed to give me an interview, she missed three appointments before I met her by chance at lunchtime one day and we arranged to meet right after lunch. On arriving, she was clearly uncomfortable, smoked several cigarettes over a short period (in my "no smoking" room), and refused to have the interview recorded - three times! Thus she exhibited anxiety in all these ways, and also expressed anxiety about "numbers". She managed to attempt only one question, and the interview broke down after 15 or 20 minutes. The difficulties of this interview were, fortunately, unique.

It should be noted that, though it was possible to code events or behaviours as "positively" exhibiting anxiety, I was less certain about coding the <u>absence</u> of exhibited anxiety. This was because another reading of the transcript might produce a positive instance. Thus there were 8 cases of uncertain coding of an absence of exhibited anxiety, and two cases of uncertain coding of no expressed anxiety.

An example of not expressing anxiety is no.17 (Sam, the young black man). The closest he came was in response to my question "How do you feel about the way [..] you're able to use numbers these days generally?":

> Not as comfortable as I was when I was younger.... get some practice again ... [2 lines] My brain's not very sharp with numbers. Usually I wouldn't want to depend on a calculator, I would want to use my head....
> (interview transcript, p.23)

This was coded as "EXP-", as not expressing anxiety, because he did not use any of the terms considered as expressing anxiety. The closest he got to exhibiting anxiety was, after calculating the price and quantity differences for Qu. 8 [best buy of ketchup], he admitted "I wouldn't like to work it out though ..." (transcript, p.19). I was not certain this reluctance was based on anxiety, and so I coded him as "EXH- (?)".

Examples of positive exhibited anxiety would include:
- a "surprising slip", or
- a denial of anxiety, or
- "unusual" behaviour, such as laughing a lot (sec. 9.2.4).

Examples of these three types were provided, respectively: by Ellen (while doing Qu.4), by Alan (throughout), and by

Fiona plus nos. 12, 15 and 22. For further details, see the case studies of the first three in Ch.11.

Both parts of the hypothesis receive some confirmation; see Table 10.8. For (i), the percentage of "EXP+" among women is somewhat higher than for men - 100%, against 75 to 92%, allowing for two uncertain codings; that is, 1 to 3 of the 12 men do not express anxiety in the interview, whereas all 13 women do. However, what is also interesting is that a higher proportion of men are coded as expressing anxiety than might have been expected.

For (ii), the percentage of EXH+ among men is 67 to 100%. More to the point, two of the three men who were coded as "EXP-" or "EXP- (?)", i.e. definitely not or probably not expressing anxiety, viz. nos. 7 (Alan) and 11, were coded definitely as exhibiting anxiety ("EXH+"). And the third man who was coded as "EXP-", and "EXH- (?)", was no.17 whom we have already discussed. On the basis of the coding done, no.17 is the only subject who might have neither expressed, nor exhibited, anxiety. However, the fact that he neither expresses nor exhibits anxiety does not of course mean that he doesn't experience anxiety: the concept of exhibiting anxiety has not been claimed to override the need for a consideration of the role of the unconscious in understanding anxiety and affect; see the discussion above in Secs. 8.3 and 8.4.

Thus we can tentatively conclude from our examination of (i) and (ii), not that women are more anxious than men, but that the women - in this sample, on these occasions, in these settings - were more "able" or "willing" to express anxiety than men. This provides an alternative explanation for the higher scores on admitted anxiety amongst women reported in many studies. Of course, it must be remembered that the statements that were coded as expressing anxiety for Table 10.8 were selected by me from all the statements volunteered by subjects in the interviews: it was not part of the interview rubric to ask any subject how he or she was feeling (though I did do that if it seemed appropriate).

Thus the interview was a somewhat different way of producing evidence of expressed anxiety (or affect) than a questionnaire of "self-report" anxiety (or affective) items would be.

Now, this conclusion may seem to suggest that this differential willingness to express or admit anxiety is itself an "essence" or characteristic of men and women in general. However, my approach to studying anxiety sees it as specific to the practice in which the subject is positioned. Thus it is important to extend the analysis so that expressions and exhibiting of anxiety can be examined as context-specific.

I can begin by specifying the context(s) in which each subject expressed anxiety in the interview. A further cross-subject analysis suggested that at least 6 of the 12 men had expressed anxiety about current or previous experiences with academic maths, and at least 10 of the 13 women; examples include Peter, Donald, Ellen, Fiona and Harriet. A further two men and two women expressed anxiety about the interview; the clearest example was no.1: while I am asking her "to take a look at a few questions here ...", she reports:

> S: I'm scared...
> JE: You're scared? Okay, why's that?
> S: I'm just apprehensive in case I get them all wrong [laughs] (interview transcript, p.2)

And one man expressed anxiety about using numbers at work - see no.8's "panic" about needing to add up the cost of drinks in the pub (see above) - and one woman referred to the fact that she would "always follow the prices [...] for fear of being ripped off" in shopping (interview transcript, p.7); see Jean's case study in Ch.11.

In addition, more detailed illustrations of the context-specificity of anxiety will be given in the next chapter. However, we need to discuss not only the expression (and exhibiting) of anxiety, but also its production. To say anxiety is specific is to say that it is produced within practices - which are just those practices within which thinking, and numerate thinking in particular, are produced. Put another way, there is an affective aspect to the production of numeracy.

The context-specific qualities of anxiety are important for the consideration of gender differences, since it has been argued above that certain practices may make particular subject-positions available in a differential way to men and to women. For example, Hollway (1984, 1989) has argued that, in many relationships, there is a pattern whereby the man "holds" the rationality and the woman holds the feelings. It will be difficult to pursue the sort of analysis (NOTE 20) required here - because of the limited interview material produced, but see the tentative discussion of some aspects of the "family dynamics" related to Fiona's case in Ch.11.

10.6 Summary

Discussion in this chapter has aimed to show that numerate thinking and performance in the interview are specific to - that is, depend in crucial ways on - the context. This context is itself constituted by the discursive practices within which the subjects have their positioning. To say that the context is "constituted" by discourse(s) is to say that the discourses "give meaning" to the situation and highlight certain aspects as relevant to (shared) goals and values, and as possible within certain social relations.

I have had to make the argument in stages. First, in my interview situations, it is possible to specify the discourses in which subjects are positioned: I argue that in this setting it was either what might be called academic maths, school maths, college maths - with positions teacher and student, or research interviewing - with positions researcher and interviewee - or likely some "mix" of the two. Second, what I call the subject's "positioning" is a resultant of the practices in which all subjects in the situation are positioned, and the discourse(s) called up by the particular subject; this is how I attempt to take account of the determinism / freedom dilemma. I also allow that the subject's positioning will be fluid and changing over the course of the interview. Third, I argue that it is possible to describe the subject's positioning in particular episodes of the interview: indicators that may be used include the explicit form of the task - and that of the setting (NOTE 21), plus unscripted interaction, including talk of both researcher and subject in the interview; these indicators are available from the transcript of the interview, and from reflexive accounts (see sec. 9.3.3).

These are the ideas that have been investigated, and that have guided the discussion of the first five Themes in this chapter. I now consider each in turn.

Theme 1 explores the idea that context can be understood in terms of positioning in practices, as outlined above. For example, in Question 1 [reading a pie-chart to find the largest group of users of water], most subjects were judged to have their positioning in school maths and most got the question correct. However, even with an apparently simple question such as this one, there were sometimes difficulties in judging the subjects' positioning. Sometimes, too, there were surprising associations with the pie chart, such as no.6's calling up of the cutting up of cakes, and other food treats, with her brothers and sisters at home. Two subjects called up discourses from school geography or from "everyday knowledge" - rather than accepting the terms of the question and the information presented. In at least one case, Fiona's, it appeared that her "refusing the terms" of the question might have a basis in anxiety or some other emotion; these issues are taken up in her case study. In response to Qu. 3 [reading a graph of changing gold prices], a number of subjects called up work practices, especially those who had been positioned in competitive business practices before joining college.

In this chapter, the coding of the "predominant" positioning of particular subjects in response to specific questions has apparently been accomplished satisfactorily in many cases. This sort of judgement has been useful in order to consider certain themes, e.g. gender differences in cognition and performance (Theme 3). Sometimes, however, it has appeared possibly to be a simplification. Therefore in the next chapter, illustrations are given of positionings which are multiple (i.e. in more than one discourse), or which perhaps might be said to be at the intersection of several discourses.

Theme 2 aimed to examine the evidence for the inseparability of task and context, as argued for in Ch.7. The main conclusions were: first, that the practice called up is not fixed according to the arithmetic or mathematical qualities of the problem; and second, that the situation described in the wording, etc. of the problem does not fully specify the context of the problem. Thus the task and the context, widely understood as in Ch.7, cannot be neatly separated, as argued by traditional views of mathematics learning. The links of numerate thinking and performance with the context are discussed further in connection with Theme 4.

For Theme 3, I aimed to consider any apparent gender differences, or social class differences, in performance in the interview, and whether they might be illuminated by differences in positioning. When we consider "correct" performance for problem 3, there initially appear to be gender differences, but these are partly explained by differences in qualification in maths - for the high-qualified (O-/A-level) only. That is, there still appears to be a lower level of performance among low-qualified women students. However, for Qu.2 (see APPENDIX U3), this relation of performance to gender and qualification differences appears to hold only for those positioned in academic maths - but not for those who were judged to have called up various numerate practices from previous work and everyday life (business, etc.) within which to address the problem (though the numbers are very small). Thus we can see that gender differences in performance may depend at least to some extent, on subjects' positioning within practices. Some further support is given to this idea by my analysis of Qu.4.

As for social class differences, for problem 8, I have shown through a number of illustrations that both the answers given and the "strategies" used by subjects, can be shown to be specific to their positionings in social class terms. These have been shown to be important in several ways. Most (four of five) subjects who used the "most general" thinking strategies were of middle class families - and most (four of five) using those two strategies got the question correct in a cogent way. In contrast, two of those beginning with strategy (4) and getting the question wrong appeared to do so because of anxieties about financial constraint. These findings, allowing for the small numbers, give some support to Walkerdine's (1988) idea that the freedom to reason in abstract ways may be enhanced by the freedom to consider a range of alternatives in a way that is free of constraint and anxiety. Several cases also point to the issue of whether a particular difference in price would be evaluated as being worth bothering about, for a particular subject; this, too, is a matter likely to be related to social class positioning.

Support for Theme 4, the specificity of numerate thinking and performance to the subject's positioning, is provided by the discussion of Qu.4B [10% tip on the chosen dish], and also Qu.2 (see above). For the tipping question, the only errors were produced by those calling up "eating out" who normally tip a specific amount, rather than a percentage (2 out of 3 incorrect) - and by those calling up school maths (2 out of 5 incorrect). Indeed the small gender differences in correct performance apparent could be explained by the fact that all those calling up school maths were women! Put another way, the gender differences in performance were less striking than the gender differences in positioning.

For Question 5 [9% rise on payslip - A approximately, and B exactly?], there again appears to have been a higher level of correct performance for part B among those calling up activities related to payslips, etc., than among those calling up academic maths (keeping in mind the very small numbers and the simplification involved in coding "predominant" positioning). Further, since the solution to problem 5 required successful completion of a series of stages, it was possible to make an error at several points. Several subjects were sufficiently critically reflective to notice an error - and in one case to correct it - but some others did not. This critical evaluation was done both within school maths and within discourses underlying the reading of payslips. Further findings on the basis for such critical evaluation would be valuable.

In Question 6, much of the interest centred on the strategies used to calculate the best buy [chosen from two bottles of tomato sauce]. As a group, my subjects showed as wide a range of strategies as were used by subjects in the two studies of Capon & Kuhn (1979, 1982) and Lave (1988). Though my subjects used unit price strategy (6) (in Piagetion terms, the most generalisable) as often as subjects in the other best buy simulations, they used strategy (5) price / quantity ratio much less and strategy (4), differencing, much more. The strategy used seemed to depend on whether the subject had called up shopping practices <u>and</u> was familiar with best buy calculations, or not. (The idea of <u>familiarity</u> with a practice will be further discussed in Ch.11.)

Besides the findings that are relevant to cognition in practice, in this chapter I have also begun to produce findings on affect (though the results are only suggestive because of the small numbers). Concerning Theme 5, women were found to express anxiety more frequently - though the difference was surprisingly small. It was argued that this seeming gender difference in expressing anxiety might be related to differences in positioning - given the tendency observed in connection with several problems for women's ("predominant") positioning to be more often in school maths (than men's). In Ch.11, the case studies will explore a range of issues, especially this and others related to affect.

A number of earlier writers have discussed numerate problem-solving, and several recent discussions have attempted to set down the basic steps involved in such processes, as follows:

(1) formulating the problem, sometimes using quantitative modelling;

(2) collecting or producing data or information;

(3) analysing data, using appropriate calculations, estimates and approximations; and

(4) interpreting the results in terms of the original problem, and evaluating them. (NOTE 22)

However, my analysis of problems in the interview, especially Qu.5 [9% pay rise], illustrates a number of aspects of problem-solving in practice that differ from this standard format. First, the steps in the process must normally be addressed within one specific discursive practice (or occasionally, the intersection of more than one); calling this up could be thought of as the basis (or the precondition) of step (1). Throughout, the thinking must be done in the context of "being conversant with" symbols and language in the relevant discourse(s). Second, the steps may be carried out in a different order, or the subject may need to retrace his/her steps: for example, some data search or extraction may be done before problem formulation, or reformulation. Third, interpretation and evaluation permeate the entire process; they depend on the goals and values of the practice within which the problem is addressed and formulated, and also the social relations in force, and the material resources available, in the context. They may relate to any stage, for example to the evaluation of the available numerical information as to its usefulness.

In the discussion of Qu.5 above, the role of critical evaluation for <u>correctness</u> was indicated. However, in any activity, whether in school maths or checking your payslips, correctness is just one of the possible goals: other possibilities are economy of effort, and, say, the saving of "face" or dignity (cf. the discussions of Cole et al.'s and Scribner et al.'s work in Sec. 7.4). Thus the problem solver must also decide what degree of precision, and what sorts of differences, are worth being concerned with (for present purposes) - evaluation for <u>meaning</u> (or goal-relevance) or <u>economy</u>.

These ideas can help to flesh out my characterisation of numeracy as N2, or numerate aspects of thinking / problem solving in a range of everyday (non-school) practices (see earlier discussions in Chs. 2 and 7). They point to a series of steps of a problem solving process - focussed on a "solution shape" and using "gap-closing" (cf. Lave), done in a flexible way, and in a way that is tailored to the context, itself grounded in discursive practice(s).

Examples of numeracy in practice should help to clarify this. First, the four steps are illustrated by the problem of estimating the length of a certain area from a blueprint drawn to scale - say, for cement posts (Zaslavsky, 1975). Here, the task involves (2) extracting data on the length of the line, and grasping (1) a relevant model (arithmetical). Thus, "So that is what we can use the multiplication table for" - an exclamation by a Chilean metallurgy worker, at a lunch-hour class on reading blueprints, during the Allende period (Zaslavsky, p.232). It also involves recognising and reading the statement of the scale (eg.1:5) on the blueprint - i.e. understanding the relevant language - and (3) computing the relevant multiplication. Finally, the result must be (4) interpreted and evaluated in the context of the original problem.

However, I have also stressed the pervasiveness of evaluation, at all steps in the process. Let us reconsider the problem of deciding how much to tip a waiter. Here, evaluation occurs at several levels: Do I want to consider tipping at all ? Is it worth doing a calculation? (e.g. if the bill reads £9.05)? Do I want to approximate by rounding up to the nearest £1, say? Then you may (or may not) choose to follow a rule:

Always tip 10%! or

Normally tip 10%, but 12 1/2 % if the waiter was especially helpful or resourceful! or Normally give £1, and never less than 50p!

Choosing a rule - or not - seems related to (1) problem formulation, and once that is done, you may - or may not - (3) compute a percentage, and approximate the result to the desired precision. This is an example of numerate problem solving which does not necessarily involve any arithmetic or "mathematics". (NOTE 23)

There are still outstanding issues from the discussions of this chapter. For example, the analysis needs to be broadened to consider interdiscursive positioning, rather than simply "predominant" positioning. Also, can anxiety appear linked with - or even in the guise of - other feelings? How is the expression, or the exhibiting, of anxiety, or other feelings, specific to the context? And are there alternative ways of understanding the relationship between cognition and affect? These questions lead us on to the remaining Themes, and to the discussion of the case studies, in Ch.11.

CHAPTER 11: INTERVIEW RESULTS - CASE STUDIES

> If race and class, poverty and wealth, mental and manual labour, produce differently regulated practices, then it is important to examine a multiplicity of subjectivities produced in such conditions.
>
> (Walkerdine, 1988, p.215)

In Chapter 10, I addressed the first five Themes for the qualitative / interview part of this thesis, using cross-subject analyses, based on accounts of all 25 interviews. The arguments there showed several things. The N0 and N1 conceptions of numeracy are not adequate to understand subjects' thinking in the interview situation. It _is_ feasible to determine which practice(s) a subject has called up, and hence his/her positioning, in a specific situation. What may appear to be structural differences (gender, social class) in performance or expressing anxiety may often be understood as differences in positioning. And many aspects of thinking in problem-solving situations depend on the subject's positioning in practices.

The approach used in this chapter is different from that of the previous chapter. After a recapping of the remaining themes, an overview is given in Sec. 11.1 of the way in which _case studies_ will be used to discuss the themes. Two illustrations (shorter, and more focussed on particular issues than case studies) are also given in APPENDICES U1 and U2. (These could have been presented as case studies, but for time and space constraints.) Sec. 11.2 presents full case studies of seven interviews selected as explained in sec. 9.4.3. Here, the life history material is analysed more intensively than could be done in Ch.10, so as to bring out a number of themes which could not have been developed using the cross-subject analyses.

11.1 <u>The Remaining Themes</u>

11.1.1 Theme 6: Other feelings expressed or exhibited

Initial analysis of the summary accounts of the interviews showed that the subjects of the interviews expressed or exhibited a wide range of feelings which, at first sight at least, had to do with mathematics, or perhaps the numerate aspects of some everyday practice. Each case study, following the cross-subject analysis of Theme 5 - anxiety expressed or exhibited, will examine examples of anxiety. But particular case studies provide examples also of other emotions:

- confidence: Ellen;
- diffidence: Jean, Harriet and Peter;
- pleasure: Donald and Harriet; and
- anger: Fiona and Peter.

Often a number of emotions will be intertwined, and sometimes the expression of one emotion may seem to suggest <u>another</u>; for example, strong expressions of confidence may suggest anxiety - as in Ellen's case. Or indeed the <u>denial</u> of feelings may suggest their importance - as in Alan's case.

One emotion said to be widely experienced at school which is not much mentioned in the selected case studies - though it is suggested by one of Peter's stories - is <u>boredom</u>. However, it is described in both Sam's and Keith's illustrations; see APPENDICES U1 and U2, respectively.

11.1.2 Theme 7: Anxiety and other feelings as specific to positioning

In this chapter, we need to build on, and move beyond, the approach of the cross-subject analysis for Theme 5, gender differences in expressing anxiety, where each subject was coded as EXP+ or EXP-, depending on whether or not s/he was judged to express anxiety in the interview. Here we need to consider the context, the positioning, within which anxiety is experienced and expressed (or exhibited).

However, just as the use of numerate or quantitative signifiers does not make the activity in the situation under consideration "mathematical", so too the anxiety (or other feelings) expressed or exhibited in such situations is not itself necessarily or wholly mathematical. In order to appreciate the meaning of the situation, including its emotional charge, it is important to specify the subject's positioning in practices. In this way, I analyse several instances of what might appear to be "mathematics anxiety", using the case studies of Jean, Ellen, Fiona and Peter.

11.1.3 Theme 8: The relationship between affect and cognition as specific to positioning

In contrast with the statistical analysis (reported in Chs. 5 and 6) which aimed to produce a general relationship between anxiety and performance, it was argued above (see Sec. 9.1) that it was necessary also to consider the relationship between emotion and thinking, for particular subjects, and for particular episodes of action in the interview. I argue that cognition and affect must be considered as part of a whole, and, as the basis for that integrity, we need to understand the positioning of the subject in the context of each task or action.

In these analyses, familiarity will be an important concept straddling the cognitive and the affective. Also, it will be useful to examine any surprising "slips", in terms of whether they might be explained by considering affective processes, or unconscious ones. The case studies will provide the basis of the main points of the analysis; these are supplemented by the illustration of Keith, who appeared to make more than one surprising "slip"; see APPENDIX U2.

11.2 Case Studies

11.2.1 Ellen

Interviewee No.14 - here called "Ellen" - was female, aged 19 at entry, middle class (by parent's occupation), with A-level in maths. A student of Town Planning, at the time of the interview, she worked part-time as an electronics assembler; she had worked previously in a shop. (For the reflexive account, see IV. below).

Ellen's performance on the questionnaire at the beginning of the academic year had been strong - 21 of 22 Qu. correct. For Qu.18 [a 10% tip, on a restaurant bill of £3.72], considered to be a practical maths item, her response "37.2p" was scored "wrong" (as 1p was then the smallest money unit; see Sec. 10.2). Her maths anxiety responses on the questionnaire were in the 3rd decile of the whole sample, on both numerical anxiety and maths test anxiety - but in the top decile on a measure of general anxiety. That is, she certainly would be well below average on both dimensions of maths anxiety, but well above average on general anxiety. Thus her scores seem to fit well the "inverted U" relationship between PERFS, school maths performance, and TA, maths test anxiety: a very high score on PERFS (10 / 10), and moderate to low TA score (3.3 out of 7); indeed the "residuals" when both models for PERFS (see Sec.6.3) were fitted for her were within 1/4 of a question in both cases. (NOTE 7)

In the interview, all six problems she attempted were ultimately "correct", though Qu.4 begins with a slip! - see below. She expresses overwhelming confidence after almost every question in the interview, e.g. for Qu. 1 [reading a pie-chart] : "very familiar,...know exactly what it means... don't have to think about it..." (interview transcript, p.3) - except for Qu. 4! For most questions, this subject seems to be positioned in school maths (SM). For the transcript of this interview, including her "worksheet", see APPENDIX S1.

Let us look more closely at Qu.4. When I ask what a 15% service charge would be for "her" meal [costing £3.53], she says "Well, I'd have to use pencil and paper". Then -

> S : [7 sec. / inaudible / coughs / 6 sec.] Well, 23 1/2 pou- no, that's wrong ... [12 sec.]...what I've done wrong, oh (JE: Is it wrong?) Yeah, umm [laughs nervously] ... I don't know what I'm doing...
> [She realises she has <u>divided</u> 15% into £3.53, and begins to redo the calculation by multiplying the two numbers - see her worksheet.]
> JE: You might not be used to doing these questions in such a setting as this, so (S: Yeah) take - there's lots of time, don't worry....
> S: [15 sec.] ... 52.95, 53 pence.
>
> (transcript, p.7)

But she recovers from her slip, and explains that she rejected the answer produced by dividing because "I just saw that it was obviously not right... it was far too small" - an example of "critical reflection" (see the discussion of Qu.5 in Sec.10.4).

Thus, we can produce a <u>1st Reading</u> of the episode: The "slip" may be just that, an aberration, perhaps brought about by her response to the relative difficulty of a question requiring the calculation of 15%, as compared with the first three questions. So far, she has expressed only confidence; here, she momentarily expresses confusion - surprising for someone who has A-level in Maths (though no.22, another young woman with A-level maths also makes the same type of slip on Qu.5 [9% increase on payslip] - see Sec. 10.4(b)). It is possible to conjecture that she is feeling some anxiety, and it appears to be "maths anxiety" (or perhaps "interview anxiety"). This is the sort of analysis that a "clinical interview" would produce. But let us consider this episode more closely.

What is the context of this performance, and of the anxiety that she seems to be experiencing? In response to the first contexting question asked, whether she ever went to a restaurant with a menu like that shown, she had seemed to reply very quietly and hesitantly - and this was before any numerical problem was posed. After she "chose" the seafood platter [£3.53], I ask how much she would tip for a restaurant meal: she had replied, again somewhat hesitantly, "...well, 15%, I suppose..."(p.7).

After she has performed the calculation with the result described above, I ask

> JE: Does this sort of situation here remind you of anything, any earlier experiences, a restaurant, a meal, thinking about service, and so on ...?
> S; No ... I don't usually pay ... I mean, I usually look at prices and things, ... add them up in my head...
> JE: Even if you're not paying?
> S: I don't want to be an expense.
>
> (transcript, p.8)

As well as being positioned in school maths (SM) and being interviewed (RI), she calls up in response to this problem a practice (or cluster of practices), which might be called "eating out at restaurants". Thus, for this problem, her positioning is "inter-discursive". At the beginning of this episode, she seems to have called up eating out: she chooses a dish and produces a rule for tipping. However, it is not clear how familiar she is with this practice - or at least with a position of tipping within it, as she reverts to using pencil and paper - which in this context is likely to be indicative of SM - to calculate a 15% tip. As for her "critical reflection" that her first answer "was obviously [...] far too small", either the SM or the eating out discourse could support that.

Similarly, we could attempt to understand her anxiety as specific to one, or more, of these practices. It might be:

(a) anxiety experienced about the question (SM) itself - maths test anxiety since she is not confident about doing a slightly more difficult calculation (a 15% tip) than she has so far had to do - as in the 1st reading; or

(b) anxiety to do with the interview (RI) itself, which she is experiencing as an evaluative situation; or

(c) anxiety recalled about eating out and about doing the right thing in a restaurant.

Support for (c) comes from her hesitation, etc. at the presentation of the restaurant menu; and "I don't want to be an expense"; i.e. the anxiety seems to be exhibited before the 15% calculation has been mentioned, and to interfere with her doing it. (This interpretation might receive some further support from the fact the only "wrong" answer on the questionnaire was the calculation of a 10% tip on a restaurant bill of £3.72 as "37.2 p".)

Support for (a) and (b) comes from an analysis of her responses to the questionnaire anxiety scales. Of the four items she reported highest (as "6" = "I would be moderately anxious"), two were from the maths test anxiety subscale -

T25: taking an examination for a maths course; and

T35: completing a surprise maths quiz. Thus she might well be anxious about the interview, once it was clear that it would involve doing maths problems under the gaze of myself, a maths teacher. A counter-indication for (a) and (b) is that for the next question, she had to calculate a 9% pay increase, also on paper, also a difficult calculation, but she got it right. In the transcript, she does not appear to exhibit many indications of anxiety for this later problem.

Now, calling the anxiety "mathematical", as in the 1st reading, would be accurate only if we were to assume that she was positioned solely in a college maths / school maths discourse. It would not be appropriate if, as I argue here, she has a positioning based in "eating out" as well as in SM, and perhaps also as interviewee.

We can note the specificity of her positioning in gender, and perhaps age and social class, terms. Her specified rule of tipping "15%" would have been very unusual for most people, especially students, in 1986; it is mentioned by only two other subjects, one of whom, Jean (see next case study), is about to leave for the USA, where that level of tip was more customary. Suggesting 15% tips might seem to indicate "wealth" and "generosity", but, as a 19-year old student, she has to have a job in an factory (interview transcript, p.2) and to limit herself to £15 when shopping for food (p.11). The wealth and generosity seem likely to be someone else's.

Indeed, it later emerges that she "doesn't usually pay" in the restaurant. And she mentions that she doesn't want to be "an expense". The position of not paying when you eat out is one which is relatively more available to women, or to people younger than their hosts. Also the restaurants where she ate were likely for middle-class patrons, or at least for those not constrained financially.

The term "expense" signifies in different ways - as an amount which could be arithmetically calculated within a mathematical or related discourse, or as being a burden within a relationship with other(s) more powerful in resource terms and on whom the subject is dependent (a parent or partner). This signifier thus functions at the intersection of these two discourses. Its negative connotations in the latter context suggest that its use also <u>exhibits</u> anxiety: it is likely to call up anxiety associated with the activity of eating out, with the related social relationship(s), and with the operations involved in the activity, e.g. choosing a dish, calculating the total cost of her meal. In addition, the play across these different senses, related to different positionings, itself may generate anxiety (NOTE 1).

Thus, my <u>2nd reading</u>: It is reasonable to suppose that Ellen may be positioned in a combination or "mix" of more than one discourse - in eating out, in school maths, and perhaps in being interviewed. Her performance, the methods used, and the possibilities for critical reflection need to be understood in this context. Similarly, the anxiety that she seems to be exhibiting also needs to be described in relation to this positioning. It would not be "mathematical" (only), if she is positioned in discourses other than school maths or college maths. The anxiety that seems to have been triggered by this question is, at least to some extent, anxiety about the context of eating out, about the relationship(s) in this context, and about being a burden in that relationship.

But there still seems to be a conflict or contradiction between the picture she gives of overwhelming confidence about maths and the use of numbers, and the indications of anxiety in this (and other) episodes. Is she perhaps "protesting too much"? This question (and others) suggest a need for insights from psychoanalysis for the interpretation of my interviews, using ideas from Nimier (1978), Legault (1987) and Hunt (1989) (see secs. 8.3.2 and 9.2.3).

I. Can this subject's repeated expressions of confidence be interpreted as a defence against anxiety? Let us see how she feels towards the end of the interview. When I ask how she feels "about the way you're able to use numbers these days":

> S : [6 sec.] I feel, sort of, confident, I suppose, 'cause I feel I <u>should</u> be confident (JE : Why...?) Well, um, [4 sec.] given the sort of qualifications that I've got, and that the course is aimed at people who have less [....] the numbers aren't, uh, don't really give me the problem, the working, you know, the calculations. But it's more sort of [3 sec.] [quietly] talking about them [laughs nervously]... I don't know if anything gives me problems but...on the most recent worksheet, there's the bit which I've - groan when I think about it, about talking about how you might <u>use</u> numbers [3 lines] ... I'd just be much more interested in doing a calculation, getting an answer you know, having that done...

... [6 lines] ...

S: ... that being it, and having to come up with some [4 sec.] answer, a definite answer. But [...] maybe I just don't find it very interesting [laughs nervously] [...] it might be too different, you know, I certainly just find it easier to do the actual maths....

(transcript, pp.12-13; her emphasis)

There are (at least) two possible interpretations for the expression of confidence in this episode. (NOTE 2) We could take it at face value: she has grounds for confidence about calculations, but not concerning interpretations of data, etc. - which make her "groan" - an expression of anxiety, or dread, or some other negative affect. Or it might be basically a defense - against anxiety in all spheres of maths. In either case, the expression of confidence covers up some amount of anxiety - exhibited e.g. by the instances of nervous laughter - and it can be seen as a defence against anxiety. (NOTE 3)

II. Hunt's assumptions that unconscious images and thoughts sometimes appear as jokes, slips, etc. point to Ellen's slip in calculating a 15% tip, and especially to the content of the slip: involving division rather than multiplying, it led to a result that was smaller than it should have been. This is perhaps not surprising when we remember that she later admits to not wanting to "be an expense" - we might say that her slip was "motivated" by the anxiety. Some further support is given for this when we note that she chose the least expensive dish - the seafood platter at £3.53 - though of course there could be many other reasons for doing so. Thus we can note the role that unconscious anxiety may possibly have played in the sequence of responses made by this subject. (NOTE 4)

III. We might also use insights from psychoanalysis to examine more closely the ideas from the 2nd reading - that of the location of the signifier "expense" being at the "intersection" of two discourses, and the idea of the "play" of meaning across its different senses. A relevant illustration is provided by Hollway, using the signifier "oranges"; see Sec.8.4. There "peeling oranges" had meanings for the man which were not rationally accessible through the definitions of oranges or of peeling: they were part of a wider set of meanings around proof of loving and of caring, through women doing things for him. Thus the meaning of "oranges" was related to this man's own particular history of desire (Hollway, 1984, pp.250-51; and 1989, pp.58-59).

Here we can use the ideas of metonymy and metaphor, and their links with the defence of displacement and condensation, respectively (see the discussion of Lacan's work in Sec. 8.3). The idea of being an "expense" may be linked - metaphorically - in this woman's history, with that of being a burden in a relationship, one that is infused with desire. Because of anxiety, guilt, pain, etc. associated with this, the signifier is likely to be "suppressed". When a problem is presented involving choosing from a menu - with prices attached ! - and when she is asked to calculate the amount of a tip, this will be linked - metonymically, through the idea of summing - with the signifier "expense". This signifier thus is located at the intersection of two (at least) discourses, and this linkage allows the strong feelings based on desire in the discourse(s) around her relationship and eating out to be associated with this particular problem - which appears so very mathematical! We could say that multiple meanings are <u>condensed</u> on the signifier "expense". And we can see that this subject <u>displaces</u> her anxiety about being an expense by moving along the chain metonymically and focussing on a sum!

IV. I must also consider why I departed from my normal script for Qu. 4 with this subject. Here is where my <u>reflexive account</u> for Ellen can be useful. I was not aware of having met this student before the interview; our pedagogic contact would have been confined to the 1st year Maths lectures that I gave (to 160 students, the BASS 1985 sample). In the interview, I was struck by the fact that she had A level maths, an exceedingly rare qualification on the BASS course (attained by only 7% of that year's entry overall), and convinced at first by her expressions of confidence. I was concerned about how the interview was going, and in particular, that she might be bored with such easy questions.

Then came her responses to Qu. 4. At this point, given the "opening" by her mentioning 15% as a tip, I asked her what a 15% tip would be, i.e. gave her a more difficult problem for the second half of Qu.4 than I did to the other subjects.

With psychoanalytical assumptions in mind, we can see that the standard "reflexive account" needs to be augmented. On reflection, I was able to recall feeling some anxiety myself: this was only the second interviewee that I didn't know in 1986 (which I hoped would be the final round of interviews). The decision to give this subject a more difficult problem can be seen as "motivated" by inter alia an anxiety that she would find the problems too boring, and that the interview would not be a "success". This can be seen as an example of "transference", the subconscious reaction of myself as researcher to the subject, based on the imposition of images onto her - e.g. boredom - for which there was not any evidence. (NOTE 4a)

To sum up, this analysis questions whether anxiety which might at first seem "mathematical" does indeed have this basis, and illustrates how anxiety may be specific to another discourse (or set of discourses) positioning the subject. I also argue that the relationship between anxiety and performance, rather than being simply general across subjects, can only be fully grasped through analysis of a particular subject, having a specific positioning, as is done here. This analysis must be related to specific discursive practices - indeed to specific "key" signifiers - and to a positioning that may be "interdiscursive"; positioning also is related to social differences such as gender, class and age.

This analysis shows how to extend the usual qualitative methodology in order to provide a fuller discussion of affective issues, e.g. through using contexting questions. Further, the usefulness of psychoanalytic concepts of displacement and transference has been demonstrated, for example in explaining how a "slip" in mathematical problem solving may be produced. The interview also illustrates the expression of confidence as a defence against anxiety.

11.2.2 Jean

Interviewee no.3, called Jean, was female, aged 18 at entry, with CSEs in both Mathematics and Arithmetic. She had a part-time job in a pub at the time of the interview, and had previously had several jobs while at school and college (shop, cleaning, milk round). Though her year of entry, 1984, was one for which there were no social class items in the questionnaire, I judged her to be working class, on the basis of a noticeable regional accent, and an often-voiced concern about never having enough money (see below).

Reflexive Account: I knew this student only by sight. In the first two terms she (like interviewee no.1) was a member of Group "X", a group with whom I had good relations, though I did not tutor them. Besides having me as a lecturer for 1st year maths, as an intending Social Worker, she would have expected to have lectures (and perhaps seminars) from me in the second year. She must have been recruited to an interview by the random sampling exercise (see Ch.9). This was only my third interview, and the first with a student that I did not know fairly well.

On the questionnaire, she scored 16 of 22 correct, a performance in the lowest third of this sample. Qu.18, the "10% tip" question was wrong and she got "stuck" in setting up the formula for Qu.24, another percentage question (see below). In other parts of the questionnaire, she rated herself as "not very capable" on percentages, and "not at all capable" on decimals. She expected "a great deal of difficulty with Maths in your studies at the Polytechnic", and would like to learn "percentages and decimals" in Maths "this year" (i.e. in 1st year). Her anxiety responses on the questionnaire were 5.2 out of 7 for numerical anxiety (99th percentile of the whole sample), and 5.2 out of 7 for maths test anxiety (7th to 8th decile of whole sample), both indicating more than "a little anxious" on average. But it was unusual for a subject to score as high on NA as on TA.

In the interview, Qus. 1 to 3 were done correctly, except for Qu.3A [time of fastest rise of gold price] - but see her later remark that she doesn't like gradients and they are pointless (transcript, pp.9 & 18). For Qu.2 [10% of 6.65] she sets up a formula on paper, but then produces a guess. There appears to be a "break" in performance after Qu.4, after which she does not get any question correct.

A major issue in considering her performance is: Why does she "always get %'s the wrong way round"? She seems to call up school maths and (selection) tests for school and work for Qus. 2 and 4. (NOTE 5a) In one of her attempts at Qu.2, she tries {10/6.65 x 100}, but then realises that is incorrect, and gives the answer "0.65", which she says is "just a guess" (transcript, p.4). How did she come up with that? "I just moved the dot." (p.5)

The problem shows up most clearly in the second part of Qu. 4: after she has illustrated her tipping practices by saying that for a meal costing £2.75 she would leave £3, she attempts to respond to my question about a "10% tip on £3.75". (NOTE 5) First, she tries { 10/3.75 x 100 }, as for Qu.2, and then, she tries { 3.75/10 x 100 }. But she doesn't really know: "it goes something like that" (p.8). And from then on, her performance goes downhill.

It may be helpful here to look more closely at the questionnaire (completed the previous October). Recall that subjects are responding under some amount of time pressure - 10 minutes for 24 questions. She gives an answer to Qu. 18 [10% tip on £3.72] as "72p", which is difficult to explain - unless she is using some rule such as "Take the last two digits"! She correctly sees that the final question (which was deliberately constructed as especially difficult) on the questionnaire requires her to take 44 (the % intending to vote for Jones) over 78 (the total % intending to vote, excluding "Don't Knows"). But when she sets up the formula with "100" in it, she gets "stuck" at {78/100 x 44}. Ironically this is the structure she needs to solve the "percent of" problems above, whereas Qu.24 requires a transformation of a fraction to a percentage.

This evidence from the questionnaire and the interview points to a conceptual problem - which <u>might</u> be helped by the distinction (between types of percentage problem) given above. However, is anxiety likely to be involved here as well?

The main affective themes in the interview are indeed anxiety, diffidence, and worry, constantly expressed or exhibited. (NOTE 6a) She begins diffidently: "I sound horrible on tape" (p.1); this may be <u>exhibiting</u> anxiety about the <u>interview</u>. Then concerning her CSE Grade 3 in Maths: "I wasn't very good at all"(p.2). She also <u>expresses</u> a great deal of anxiety about <u>percentages</u>; e.g. "I always get the formula wrong...", etc.,etc. (p.4); "I'm going to have to learn percentages again..." (for the USA, p.7); "I always mix it up" (p.8). These are examples of "self-defeating self-talk" (Tobias, 1978).

But it is striking that she seems to express even more anxiety about <u>money</u>. For example, "I've never, ever got enough money" (for tips, p.7); about the level of tipping required in the U.S. to which she is about to depart, and about being able to afford 15% (pp.8-9). She is also anxious about being able to afford the trip at all: "I haven't had a holiday for three years, so this will get us to America: it's the only way I can ever make it..." (p.18). When shopping, "I do always follow the prices,... for fear of being ripped off" (p.7), and with wage slips, "Yeah, I follow them through as well" (p.10). What might have appeared at first to be "maths anxiety" seems now to be part of the fabric of her constant worry about money and financial constraint.

Thus we can now see that her errors in the percentage questions, particularly Qu. 4 about tipping, may be based in a complex of factors: a conceptual problem about percentages (see above); along with

(a) maths anxiety, especially about percentages;

(b) some anxiety about the interview; and

(c) anxiety about the relevant practice, viz. tipping in restaurants, and / or tipping in the USA. The latter anxiety also relates to an apparently chronic anxiety about money (rather than, say, to a worry about what the waiter might think or do, as in the case of Peter, to be discussed below).

As for the apparent "discontinuity" in her performance (from Qu.4 onwards), the interview was of course constructed to offer the subjects a concentration of percentage questions - three out of the first five. This might well increase the anxiety, and hence inhibit the performance, of anyone especially anxious about percentages. For Qu. 4, her attempts seem to become random - she makes two guesses, both wrong. For Qu. 5, her answer to the first part [9% of £66.56, approximately] is unaccountably wrong ["about £1.50"], and she refuses to attempt the second part [same problem, but an exact answer required] - though she is not the only one to refuse (see sec. 10.4(b)). Two other possible reasons for her anxiety to increase and her performance to decline as the interview proceeds can be found in the sequencing of interview problems. The percentage questions move from 10% to a discussion of "tipping", which for her is associated with 15%, a larger amount, and also with worries about money for her imminent USA trip. Also, the change to more "practical" problems, from Qu.4 onwards, is also a change to problems which are exclusively "money-based" - on tipping, amount of wage increase, best buy, cost of baking a cake, cost of sports kit.

For these "everyday" practices, it is important to examine further her positioning in social class terms. (NOTE 6) The chronic anxiety about money is likely related to a positioning as a member of a family with money problems, and possibly poverty. Although, like Ellen, Jean seems to feel anxiety about tipping, Jean's anxiety about tipping has to do with anxiety about <u>money</u> - not having enough of it. On the other hand, for Ellen, a middle class woman of about the same age, anxiety about calculating a tip relates to anxiety about the <u>relationship</u> which has provided the site for her affectively charged experiences of "eating out".

Jean makes a distinction between two types of maths - which is also expressed in slightly different forms by several other subjects. Having done both CSE Maths (Grade 3) and CSE Arithmetic (Grade 2), she distinguishes the latter as "useful", "should be compulsory" and the former as "not useful", "I don't like it" and "should be an option" (p.18). She also distinguishes the topics in 1st year maths at the Poly in the same way; e.g. percentages, graphs and statistics are relevant, but "gradients" and algebra (p.9) are not. See further discussion of these distinctions in Sec. 11.3.

A possible defence against anxiety exhibited by this subject is what might be called "insouciance". For example, during her thinking about Qu.7 [cost of baking a cake]: "I couldn't remember how many ounces is in a pound: I might have put 16 for the flour and 12 for the sugar, or vice versa; then again, I might not have...." (p.12-13). This might be a type of defence against possible failure to solve the problem.

In addition, this subject makes two errors in questions later in the interview. For Qu.6 [best buy choice from two ketchup bottles], she chooses the smaller bottle:

> S: ... it's cheaper than that one, and [...] the 17p price difference, more relevant [...] because of the difference in the ounces, the 10 oz., I think it works out cheaper in the long run...
>
> (transcript, p.11)

She seems to be trying to compare the price difference between the two bottles with the quantity difference - a common strategy (4) in this sample (see Sec.10.4) - but she seems overwhelmed by the price difference. Thus her strategy was coded as (4) / (1), since she seemed to revert to strategy (1) (extraneous, task-extrinsic). Her answer was recorded as "incorrect" in the context of a best buy problem. However, for someone worried about money, it might well be more "relevant" to buy the smaller bottle. (No.1, another working class woman, made a similar "error" in this problem.)

For Qu.8 [cost of sports kit], her response is coded as too small, though it is correct for one of each piece of clothing, but not for the problem as asked (which involved buying a change of socks, shirt and shorts). Again, we can see that this error might be "motivated" at an unconscious level for someone who was worried about money, and concerned to limit expenditure.

Jean's interview allows me to explore a number of themes:
- "cognitive" difficulties with percentages;
- a range of anxieties, to do with percentages, maths tests and exams, the interview, and money;
- an apparent "discontinuity" in performance (from Qu.4 onwards);
- issues related to social class positioning;
- a distinction between two types of maths (also found in slightly different form in other subjects).
- use of psychoanalytical insights into an example of a possible defence against anxiety ("insouciance"); and
- examples of errors in calculations which may be motivated by the subject's deep affective "investments".

11.2.3 Fiona

Interviewee no. 5, Fiona, was female, aged 26 at entry, middle class (by parent's occupation and by her own). Her qualification in maths were " a very poor CSE grade and a very poor [O-level] grade" (interview transcript, p.2). Intending to train in Social Work, she had struggled hard along with several other students (including Keith, no.4), to be allowed to proceed to this through the Psychology Track, rather than e.g. via the Social Policy (like Jean) or Sociology Tracks - despite the fact that Psychology was considered a more "quantitative" Track. She had worked in several positions as an unqualified social worker before coming to college, where she used numbers very little. She had also had a short spell as a financial adviser, where she needed to use numbers "a lot". (For the relexive account, see V. below.)

On the questionnaire, her performance was rather poor - 13 out of 22 correct (PERFS = 7, PERFP = 6; i.e. in the bottom quarter of the sample). Given her O-level in maths, this is rather hard to interpret. Her anxiety responses may help: on numerical anxiety, they averaged to 4.1 out of 7 ("neither relaxed nor anxious", but between the 7th and 8th decile of the sample); on maths test anxiety, 6.0 ("moderately anxious"); and on general anxiety, 4.9 ("a little anxious"); both of the latter scores were around the 95th percentile of the whole sample. Thus, she illustrates a "moderately good fit" to the inverted U relationship between school maths performance and maths test anxiety: unlike Ellen and Jean, her observed score on PERFS (7 of 10 questions) was <u>less</u> than would have been expected for both models for PERFS (see Sec. 6.3), given her maths qualifications, age, maths test anxiety score, etc. - by 1/2 to 3/4 question (NOTE 7). So in the interview it will be important to examine whether there are any particular influences or features of her situation, which would tend towards <u>under-performance</u> in this sense.

In the interview, during the initial discussion of her educational and work history, she mentions that she was very "unlucky at school":

S: ... I had a very, very good maths teacher. She was very, very aware of people's problems [...] she used to work through step by step ... and then she left a few months before I actually sat both my, the CSE and the O level, and I went downhill very rapidly. I don't know whether it was a question of confidence, or inability [2 lines] ... I just felt that once she'd left, it became - it sounds funny - but it became very, very <u>mathematical</u> ... [...] Nothing, after she left, nothing was explained. We were just given the formulas and told to get on with it....

(transcript, pp.2-3; my emphasis)

This theme of "sudden decline" or discontinuity of previously good performance in school mathematics, was one which emerged in a number of interviews (NOTE 7a)

When I ask Fiona to "take a look at a few questions", she responds immediately: "Oooh [quietly] [...] paranoia's struck [...] Are they simple?" (p.4). This is an example of what I originally called "mock-anxiety", in that these appear to be expressions of anxiety, but are expressed in such a way as to raise a question about whether they are genuine (see below). For Qu.1, though she was asked to "look at this pie chart", she answered, not by reading the chart, but by referring to allegedly empirical facts from her everyday knowledge about the relative amounts of water used by households and by industry, at the national and the individual level. Thus she avoids SM, and positions herself in a discourse that might be called "general knowledge"; this leads her to refuse the terms of the question, and to give the response "industries", which is wrong. She goes on:

S: ... it reminds me of a cake or pie, umm, but also having to work out percentages at school of [...] how many portions [of cake] I could get inside a particular shape... I always had difficulty with that, I didn't enjoy it at all. School wasn't a particularly happy time for me anyway, so you might well find that a lot of my answers are negative ... [4 lines] ... I was never explained how to work through it step by step so

> it certainly makes me feel very anxious [...] I don't actually trust my own perception to actually give the correct answer, because I don't feel I [..] know how to work it out properly, so therefore I don't think I would give the right answer - if that makes sense....
>
> (transcript, pp.4-5)

Thus, she returns to school maths in response to contexting question (R), though she avoided it for actually solving the problem. A reason for that may be suggested by the fact that school, and school maths, are sites of so much negative affect for her: lack of enjoyment, unhappiness, anxiety and lack of confidence.

When I show her Qu.2, an abstract problem [10% of 6.65], she again produces "mock-anxiety": "[laughing] Horror, yeah, shock, pain, anxiety..." (pp.5-6).

For question 3 [graph of the price of gold - A: period of fastest rise, B: lowest price that day], she appears to get lost in the detail of the gold price changes, for reasons which emerge:

> JE: ... which part of the graph shows where the price was rising fastest?
>
> S: [...] there doesn't actually seem to be any time specification along the bottom which I find quite confusing [...] my father's a stockbroker, so I <u>do</u> understand a little about opening and closing ...
>
> [6 lines] ... I mean there actually appear to be two peaks here, but I should say maybe when gold is at 650, it seems to rise very rapidly in the afternoon until close, and afternoon business, you know, afternoon trading ....
>
> (transcript, p.8; her emphasis)

She then confirms that she considers the price to be rising faster in the afternoon (rather than the morning) - which is wrong. Again, it appears that she refuses the terms of the question, and draws on information from an "outside" discourse to answer. She then goes on to read the lowest price of the day as $580 rather than $590.

Thus, for this question, though she also mentions college maths - "graph work" (p.9) - in response to contexting question (C), she seems to call up what might be called "money maths", from the position of a stockbroker's daughter who "wouldn't understand":

> S:...my father dealt with money all the time, um, because he was a stockbroker and therefore it was the essence to him and his making a living, um, but it wasn't anything that we were allowed to sit down and discuss or even talk about or offer advice, or him offer advice to us [...] we were always told we wouldn't understand [...] because time is money, money is time and he hasn't got time to explain to me the information that he thinks is going to be relevant to me at a later date because I'm a woman and I don't understand...
> JE: Is it - a woman, or you're a child?....
> S: I think it's very much both....
> JE: What about your mother? Does she, is she allowed to ask questions?
> S: Well, no, no, just the same. Family and business should never mix [...] my mother wasn't ever allowed to ask and it certainly affected her far more than it did us because as a stockbroker, your home and your material valuables are on the line all the time [...] on a couple of occasions the family home was under great threat [...] It wasn't something that family and children discuss ... [2 lines] ... he was the man of the household and he could deal with it [...] ... most of the time, it was like living under a time bomb (JE: mmm, mmm, I can appreciate that) especially if you don't quite know how the time bomb's made up or when it's going to explode....
>
> (pp.9-10 of the transcript)

When I asked how she saw his work, to pick words, adjectives to describe his work, she replied:

> capitalist, corrupt, business-like, ... um, mathematical, calculating, devious, unemotional..."
>
> (transcript, p.11)

There is a lot of information about her perception of family life and there is a lot of feeling expressed and exhibited in this passage (and in the preceding ones, not quoted here). First of all, she seems <u>angry</u> at being positioned as a child who is deprived of information about her father and his work because she "wouldn't understand": this is shown by the range of sometimes ambivalent, but basically negative words she uses to describe his work. This lack of knowledge is linked to the <u>anxiety</u> she exhibits - perhaps most graphically in her comment that growing up with a stockbroker as father was "like living under [sic] a time bomb ..." And being positioned as a child who "wouldn't understand" is likely to have contributed to the lack of confidence in school subjects including mathematics - mentioned in her list of epithets for his work - that she outlines above.

This lack of potential for understanding is related to her being a child, and also perhaps a woman, Thus the story illustrates how what we might call "adultism" and sexism expressed within family or other non-school discourses may undermine a child's confidence towards school material like maths.

When we move on to the more practical questions, Qu. 4 seems to call up eating out -

> S: [...] where I'm going to get something special [..] not something that I can cook at home. I don't believe in wasting money .... I guess that's something I've been taught from an early age, not to waste money.... [...] I've also worked in one of these, so I know what goes on behind the counter [laughter]
>
> JE: [..] Would you mind choosing a dish from that menu?

S: [..] I'd go for the grilled trout...

JE: Right. Now supposing at this place, service is left to the customer -

S: - so when you take me out, that's what I'd like ...

JE: I see, oh, I see, OK, I'll remember that [she is laughing] So, [...] what would you do about leaving something for service?

S: It's usually 10%, isn't it? [..] so now you're going to try and ask me what 10% of £3.81p is ...

JE: Yes, could you?

S: I thought you would [laughter] - oh, bless you! Yeah, I could hate you. No is the answer to that [both laugh ... subject laughs] Well, it would be about 38p, but I think that's awfully mean ...

[6 lines] ... if ever I was taken out for a meal as a treat [...] it was always the male that was left to deal with the paying of the bill and the tipping, unless [...] I said I was going dutch ...

(transcript, pp.11-12)

This episode reveals several things. First of all, when a problem which is "mathematically similar" to Qu. 2 [10% of 6.65] is posed in the eating out context, she has no difficulty with it - perhaps because of her familiarity with the operation of calculating tips both as diner and as restaurant worker. Next, though she comes from a middle-class family, as does Ellen, she is somewhat older, and she is positioned differently in the discourses around eating out: she has sometimes paid for her own meal (and tips), and she has been taught to regulate her eating out, so that she does not "waste money".

Finally, she shows herself as able to play with multiple positionings: when the problem of a 10% tip is presented, she moves from being positioned in the interview, and perhaps school maths, to "being flirtatious" - i.e. to positioning herself as a woman and possible companion in eating out. She then takes up a position momentarily in the interview and school maths discourses, by offering what we might call "mock-resistance" - because she considers it a joke - to the interview or "maths test" question: "No is the answer to that..." (NOTE 8) Finally, she calls up "eating out" to calculate the tip - with much less effort than the mathematically similar Qu.2 required.

There are several issues which would benefit from deeper analysis, using psychoanalytic insights.

I. It was valuable to make a request - unscripted - that the subject associate a chain of words, adjectives to describe her father's work. It is also interesting to arrange them horizontally in the order she expressed them, and vertically, in terms of a very rough distinction between apparently "objective" and emotionally / morally "charged" terms, with ambivalent ones in the middle.

Fig. 11.1 Chain of Signifiers in Fiona's Associations with her Father's Work

```
"objective"                      mathematical
                                   /     \
ambivalent   capitalist  business  calculating  unemotional
                 \           /  -like     \            /
"charged"         \ corrupt /              \ devious /
```

The overall chain of thinking begins of course with the graph showing the changes in the price of gold, including one substantial fall at the start of the day (see Qu. 3 of the interview in Appendix I2). She associates this with her father and his work several times; there may be a defensive displacement from the father to his work. In this chain, we can expect the affective charge, based on desire for her father, to flow between signifiers. The final signifier is "unemotional", which may also signify her father's rejection of her questions about his work, her wish to give advice, and thus of her. Perhaps the central signifier in this chain is "calculating": it is located at the intersection of the family discourses about the father / his work, and the mathematical discourses. In the former, it exhibits or signifies disappointment and anger (and anxiety), which is supressed; in the latter of course it signifies a central activity of the discourse - and this may explain her resistance to getting clear how to calculate, in school mathematics at least; see the description of her actions in the 1st year maths course, in the reflexive account below.

II. It seems that, while she was growing up, there was a "splitting" (Hollway, 1984) in the family: the father practised the rationality, while the rest "held" the emotions, especially the anxiety, the insecurity about what might happen if the rationality carefully arrogated to himself were not sufficient and the "time bomb" exploded. The signified of the time bomb is the anxiety: though it may seem to be generated by the "mathematical" graph, and therefore to be "mathematics" anxiety, we can see from this analysis that a more accurate - and useful - description is possible; namely, that certain elements of the problem signify (practices which in turn signify) strong (perhaps suppressed) feelings - here, anxiety - in a way which is particular to that subject, and specific to the practices in which she is positioned.

Thus, being a child, as well as a woman, relieved her of the need during childhood, to do calculations, to be rational: her father did that. This seems to extend into adulthood, if she was ever taken out for a meal, it was generally the male that was "left" to deal with the paying of the bill (see quote above). However, she is perfectly able to calculate a 10% tip in the interview. Thus, while her father - or generally "the male" - has to perform, she is protected from that. (This perhaps suggests the "investment" that particular women may have in particular "sexist" practices.)

III. Indeed, she might feel it dangerous to be able to perform rationality or "calculating", given the chain of meanings this seems to have for her (see above). This may explain her incredible protestation of "mock-incompetence" when describing her work as financial adviser: "...

considering I can't understand any amount over £10, it was very difficult" (p.3 of transcript).

IV. What I originally called "mock anxiety", another aspect of her jokiness, can now be seen as a defence against anxiety.

V. Ideas of possible transference are worth investigating with this subject. I begin with the reflexive account. I knew this student fairly well, as she was in my seminar group in the first two terms, and also attended the (optional) tutorials regularly, as did interviewees nos. 2 and 7 (Alan), and three or four other students in the group (out of 12 or 13). She was a bright but sometimes difficult student, on occasion arriving late, fidgeting, dropping jokey asides in class. She hosted a party for the seminar group (at the beginning of Nov. in her 1st year), which I attended. Later she suggested that I drop by for a cup of tea if I was in the area; I said I might if I had time, but never did. She was one of the students selected by the random sampling exercise in late May, and she agreed to do the interview.

Her being a "difficult" student may relate to the resistance that can be better understood in the light of the associations of mathematics in the chain of signifiers with her father's work and her feelings about him. It would not be unexpected for her to transfer that resistance to me, another older man who worked with mathematics.

This interview allows me to explore a number of themes:
- a story of "sudden decline" in school maths;
- how "refusing the terms" in which a problem is posed can lead to "incorrect" responses;
- the importance of age and gender positions within particular family discourses;
- a subject's playing with multiple positionings;
- the examination of a "chain of signifiers" (see the discussion of Nimier in Sec. 8.3);
- jokiness, or the expression of "mock-anxiety" as a defence

against anxiety; and
- illustrations of transference and "resistance".

11.2.4 Harriet

Interviewee no. 16, Harriet, was 28 at entry; she was working class by parents' occupation and middle class by her own. She had passed CSE Maths (grade 2), but had not been entered for O-level. She was an intending Social Work student. As a residential social worker, she had done remedial maths (and other subjects) with her children.

Reflexive account: I knew this student from teaching her group Social Policy classes, during the first two terms. I had had several further contacts with her: once, as coordinator of 1st year maths, when she claimed "unfairness" in the different ways that Maths groups were helped with their worksheets. I was resistant to meeting her about this, and later apologised. This latter event (from some time during the Spring Term) did not seem to be on her mind at the interview, which was held on a hot Wednesday afternoon.

On the questionnaire, she scored overall only 15 correct of 22, with 3 wrong (all apparently "slips"), and 4 not attempted. Her anxiety response averages for all three dimensions were between "fairly relaxed" and "neither relaxed nor anxious", with a score on maths test anxiety of 3.7 out of 7 (between the 3rd and 4th decile for the whole sample). Her case represented a "moderately bad fit" to the inverted U relationship between anxiety and performance on the questionnaire: low to moderate maths test anxiety, but a surprisingly low score on SM, and on performance generally.

Yet her performance in the interview was excellent. Of the five questions she tackled, she did all the calculations in her head - which was indicative of her fluency and accuracy in mental arithmetic, and got them all right until she refused to attempt the precise 9% calculation in Qu.5B. What is interesting is that she seems to call up school maths or college maths for very few of the interview problems. For Qu.2, she first calls up "in a shop, working out, you know, the actual cost, how much you'd get off" (transcript, p.7). (See also the discussion of Donald's recalling a similar experience of imagining discounts.) She then immediately relates her method of working out 15% by adding 10% to half as much again. This is a report of successful creative thinking (which may be based in the recurrent fantasies mentioned just previously), though she does not give herself much credit for it. (NOTE 9) This fluent method of mental calculation can also be compared with need of Ellen - who was much more successful in school maths - to calculate a 15% tip on paper. (However, we might note that Harriet does not "find" a similar way of calculating 9% as (10% - 1%) in Qu. 5B; see below).

She then recalls helping the children in the residential home with their maths work - thus being positioned as a "teacher" and relative expert in school maths, despite the lack of recognition she received while at school (see below). Her answer "66p, 66 1/2p, if it's pence" is correct. It is interesting that she transforms an abstract question to a practical form (as did several other students; see Sec. 10.3).

For Qu.4, when I ask her to "choose a dish from that menu, ... something you'd like to ...", she responds "All of it actually [laughs, JE laughs] - I'd go back three times, I think, to have one of each..." (p.9). She certainly seems to call up eating out! (NOTE 9a) When I ask what would be the service charge of 10% on £3.53, she replies almost immediately with the correct amount of "35p".

Qu.5 calls up "payslips" for her, and she does the approximate calculation of 9% of £66.560 quickly in her head: "10% will be £6.65... just under £6" - and very accurately! When she is asked to work it out exactly, she is reluctant to try to do so in the interview, before she can recall how it was done at school:

> JE: What would come up when you tried to remember?
> [2 lines]
> S: [4 sec.] something to do with insurance ... something to do with the figure times possibly 9/100 - I'm not sure - I think I'd have to ask actually, or look it up in a textbook....
> JE: Do, there's some paper there if you want....
> S: [laughs] No!! ... [6 lines] ... I always feel much easier if I can go and look something up and check it, ... than just try and guess if I don't really know ... [...] ... - which is why I wouldn't do it now [laughs].
> (transcript, pp. 13-15)

This is an example of a "refusal" response to Qu.5B, made by 6 subjects, five of them women; see Sec. 10.4(b). She explains her reluctance to "guess", before checking the answer's correctness, by the system of credits awarded within the house system at school - and the consequent importance of "getting things right" within that competitive context:

> S: ... things I was quite confident about I'd just get on and do, but something like this which I was never confident with, I'd sort of flounder about. I think I'd find them quite difficult to do as homework as well, partly because there wouldn't be anybody to ask, at home... Yeah, homework, you're on your own: unless you've got somebody right nearby who can give you a bit of advice or a book that you can refer to, then you're stuck, if you don't know what you're doing... and I used to feel that quite a lot when I was younger - and if I didn't get it right, my dad used to shout at me {inaudible}...
> [11 lines, most quoted in the next quote below]
> ... so it was easier not to ask him for help, because then I wouldn't get told off...
> [3 lines] ... and he didn't really agree to me taking it round to other people... [8 lines] ... it was a bit awkward 'cause I lived in quite a small village and out of about 15 of us, only 4 of us went to grammar school,

> one was a boy and so he went to the boys school which was very different ... [7 lines] ... and we didn't have a phone then, so [..] there wasn't many people actually around that I could get in touch with.... I only realised that now....
>
> (transcript, pp.15-17)

Thus the school put the pressure on her to get things right, as (we shall see) did the family. In addition, she was isolated: with "homework, you're on your own".

It is important to consider her positioning in the family. She was the oldest child in a working class family and the only one to go to grammar school:

> S: ... That <u>set me above them</u> anyway, and I was <u>supposed to know</u> ... My mum was never very good at maths, and my dad - he had quite a good head for figures - but ... he expected me to know, and if I didn't, he used to tell me off, and as far as he was concerned, I hadn't been listening in class - and I should know....
>
> (transcript, p.16; my emphases)

Thus, she was positioned as "knowing" or at least "supposed to know" by her family, and also isolated, because of her school attainments. But there are two senses of "knowing" here: knowing <u>something</u>, and knowing <u>that</u> you know. At school, she had not very good end-of-term reports - and maths was always the lowest - but surprisingly good exam results. However, her father took more notice of teachers' reports, and she used to "dread" taking them home (p.4). When she got Grade 2 CSE: "I remember being quite surprised...I was that <u>good</u>." (pp.3-4). Towards the beginning of the interview, she recalls an especially poignant memory:

> S: ... At the last open evening, the teacher [told] my mum and dad that I could go on and do an O-level, A-level in pure Maths - she never said a word about

that to me... I enjoyed maths, but I never knew I could do that well ...

JE: So how did you feel...?

S: ... Cross!..."

(interview transcript, p.3; my emphasis)

Thus it seems that her career in school maths was plagued by knowing a fair amount - but not knowing how much she actually did know. Thus, she is caught between the teacher who tells the parents but not her, and her parents who have been told that she knows but don't tell her either. No wonder she "lacks confidence" about knowing. This sort of lack of communication might be read as "lack of encouragement" from home (or indeed from school), but in this case we can see it as more complex (NOTE 10). She seems to have "re-emerged" to some extent because of her activities since school, notably her teaching role in the residential home - but not completely as is shown by her lack of self-appreciation, for example about her thoughtful way of calculating 15% (see above).

As a student at the Polytechnic at the end of her 1st year, she is also positioned as an expert in college maths : "A lot of the maths that I've been doing has been stuff that I already knew, that I had to know, to help the children" (p.8). She helps other students (pp. 17, 20). She even "had an argument" with another lecturer "about whether or not you do it in such a way", and "was quite pleased, 'cause I knew I was right, 'cause I love working with logs, I love messing about with tables, I really enjoy that". (pp.8-9).

There are a number of examples of her expressing anxiety about maths, in addition to those mentioned above. She related a memory of "panicking" when she finished a maths exam half way through time (p.19). And feeling "nervous ... nerve-wracking" during the tests on "quick adding-up" at her FE college (p.2). Further, she felt "uncomfortable" about percentages, because "I'm never quite sure whether or not it's quite right [laughs]" (pp.7-8).

This relates to an _exhibited_ lack of confidence about maths - in her eagerness to know "what's _right_ ?", when I ask if there's "anything you'd like to ask about any of the questions?" (p.18, her emphasis). When I confirm that she got all of those she attempted correct, she muses:

> S: It's really odd how I need to be reassured that I'd done it right ...I'm sure that stems from years ago,... not having the confidence, I suppose ... [2 lines]
> ... because the teacher just didn't say, that, you know, yes, well done, you can do this....
> (transcript, (p.19)

Thus, she feels that she did not have sufficient reassurance or "encouragement" from school.

The other main affective theme is in this interview is _pleasure_, of which there are a number of instances. In her "argument" with another lecturer (see above), she was "quite pleased". She obviously enjoyed thinking about the dishes on the menu in Qu.4 (p.9). And it was "pleasantly surprising" that she "could do quite a lot" of maths at college:

> S: ... having a formula and ... working it out, I love that sort of thing, ... the idea, the sheer pleasure of doing that is just really very nice... I used to enjoy binary numbers ... I haven't thought about this 'til today [said with pleasure] ... I used to enjoy geometry
> (transcript, pp.17-18)

This student, like Donald (see below) and as much as any other in the interviews, is able to experience pleasure from intellectual / academic activities, including "maths problems". As far as we can tell here, this involves mostly the application of general, fairly technical, methods or formulae. (NOTE 10a) She is able to recall - and reclaim - this enjoyment in the interview, though it has been overshadowed by her failure to reach her potential at school. Her anxiety too, like her pleasure, seems to be openly expressed.

Some of these issues suggest the need for a deeper level of analysis, using psychoanalytical insights:

I. What appears to be "diffidence", or a "lack of confidence" in this subject about attempting Qu. 5B might be interpreted in several ways. She herself offers two explanations: first, in terms of competitiveness created between houses at secondary school; next, in terms of her father's "shouting at" her when she failed to know how to do her homework questions.

But this lack of confidence might be also seen in the context of her "intrapsychic" <u>conflict</u> (Hunt, 1989, pp.25ff.) about "knowing": this subject is "supposed to know", in the terms of her family, and especially her father, <u>and</u> she recalls him as showing her that he wants her to know, by "shouting at" her. <u>But</u> "knowing" - which is how they read her going to grammar school - <u>isolates</u> her, in that it "set me above them" (transcript, p.16); it can also lead to "splitting" between the home and the school (Walkerdine et al., 1989, pp.111-13). This knowing and the consequent educational success may also perhaps lead in the future to

> the trauma of leaving and isolation, the disdain with which one is supposed to view the place from which one has come and the terrible guilt that we and not they have got out, have made it, and will work in conditions which they can never know ...
>
> (Walkerdine and Lucey, 1989, p.12)

More specifically, in the episode itself (transcript, pp.13-16 - see above), what is interpreted as "lack of confidence" in refusing to try Qu.5B might signify instead an unwillingness to expose herself as "not knowing" about a particular homework problem, and therefore a shrewd desire for self-protection against the possibility of being "shouted at" (see also VI below).

II. What might <u>seem</u> like "insufficient encouragement" from home may have to do with the father's conflicts over his daughter's knowing. He appears to have had a strong "investment" (Hollway, 1984) in her "knowing": she is positioned in the family as "supposed to know", and she remembers him as showing her that he wants her to know, by "shouting at" her if she didn't. But at the same time, what it meant for her to know was that it distanced her from the family (p.16). (NOTE 11) Another illustration of what might be her father's conflict about her success is the story that she tells of her teacher telling her parents that she could do O-level maths, but her parents not telling <u>her</u>.

III. Can we now explain better why she is a "moderately bad fit" to the inverted U relationship between SM performance and maths test anxiety? The reason seems to be Harriet's SM score (5, compared with others' scores of 7 to 10 out of 10). (NOTE 12) It seems likely that - unlike the interview, where she mainly called up non-school discourses - for the questionnaire, she was positioned in school maths. As we have seen in the interview, her positioning in school maths, especially in doing homework under her father's gaze, leads her to be reluctant to tackle questions which she is not confident she knows how to solve. Further, given her positioning in school maths as "supposed to know" and yet "not knowing (that she did know)", and her conflicts - and <u>confusion</u> - about knowing (related to her father's conflicts about her knowing), it is not surprising that she would perform "poorly", and would appear to "lack confidence" in her approach to the SM items on the questionnaire.

IV. How might her pleasure in applying formulae be interpreted? There is some evidence that she experiences this as empowering:

> ... somebody gives me a way of doing something and then says you've got this bit, now go and do it, I mean I love doing that, the idea, just the sheer pleasure of doing that is really very nice ...
>
> (transcript, p.17)

Thus the formula seems to give her access to power, authority, security, but perhaps not to the full "rationality" of mathematics. The pleasure seems to be limited to a relatively technical orientation, unlike that derived from "mastery" (Walkerdine, 1988). (NOTE 12a)

V. She also reports pleasure from her "confident challenge" of the other maths tutor. Might this come from anger displaced from the maths teacher who failed to let her know that she knew?

VI. She is also resistant to attempting Qu. 5B [9% of £66.56] in front of me - recall her "No!" to my invitation to try. This might be related to her experiences of trying to solve maths problems in front of her father: it might be interpreted as an example of "transference", the unconscious "archaic" images that the subject imposes on the researcher (Hunt, 1989, pp.57ff.). However, none of the indicators that Hunt mentions for the existence of transference - dream material, fantasies, slips, jokes, or strong emotions expressed by the subject towards the researcher - has been observed in the interview material, or in the reflexive account (see above).

This interview allows me to explore a number of themes:
- the importance of her positioning as oldest child who was "supposed to know" in a working class family in a relatively isolated village, and especially the relationship with her father;
- instances of the use of "creative fantasy" in numerate activities, and the role of pleasure;
- psychoanalytical interpretations of the fantasy and the pleasure.

Further, this interview has had not only a "data production" function for the research, but also a "consciousness-raising" function for the subject: it recalls earlier achievements and satisfactions, and may make new connections. We can see this from two of the quotations above: "... I only realised that now...." (from the quotation from pp.15-17); and "I haven't thought about this 'til today" (from pp.17-18). The divergence between these two functions, and the fact that most survey research fulfils only the first, is discussed by Carr-Hill (1984).

11.3.5 Alan

Interviewee no.7, Alan, was male, aged 20 years at entry, with a CSE Grade 2 in Maths. He explains the meaning of his "Unclassified" grade in O-level: "...failed it completely ... terrible [laughs]" (interview transcript, p.2). A student of Psychology, I judged him to come from a middle class background, using as indicators his accent, and my knowing that he attended public school.

Reflexive account: Alan was a member of the group that I had taught during the first two terms - as were Fiona (no.5) and no.2, and attended both seminars and tutorials regularly. He was often very diffident about maths, but performed well in the assessment (73% overall). I got on well with him and had met him socially, e.g. at the party held by Fiona in October. There my woman companion had a long talk with him about his background and schooling. When I sensed that I might be short of men in the first year's interviewees, I asked him if he would give me an interview.

On the questionnaire, his performance on the items classed as school maths was 10 of 10 correct, but only 7 of 12 on items classed as practical maths - for a total of 17 out of 22. Those incorrect included one slip (on Qu.2 - "practical multiplication"), and 4 omitted (from Qu. 19 onwards) - which suggests he was working slowly and deliberately. His anxiety responses averaged out to slightly over 4 ("neither relaxed nor anxious") on all three subscales. For maths test anxiety (TA), this was around the median for the whole sample, whereas for numerical anxiety and general anxiety, it was around the 9th decile. What was most striking, however, was that most of his responses were 4's, with a few

3's, 5's and 6's. Thus perhaps more than any other respondent in the subsample of interviewees, his responses are clustered around the "neutral" point: Alan thus seems a "typical man".

Because of his moderate level of maths test anxiety, and his high score on SM - equal to Ellen on SM (though not PM), but about one point higher on TA, he appears to illustrate a good fit to the inverted U relationship. However, using the full models for PERFS (given in Sec. 6.3), the residuals are 1 1/4 to 1 1/2 questions, i.e. within about one standard error. (NOTE 7) Hence Alan provides only a "moderately good" fit to the inverted U relationship between SM performance and maths test anxiety.

In the interview, of the six questions he attempted, all were correct except for Qu. 5B, which he refused to try (see below). When I ask what Qu. 1 reminds him of, he is impatient to give me a "statement" about his feelings about maths:

> S [abruptly] It reminds me of earlier maths - uh, concerning my feelings about maths , I'm - it's <u>very</u> neutral - I don't have any strong feelings about maths. I have difficulties in maths, but um, and, I can't concentrate for too long on maths ... I don't have <u>worries</u> about it, I just stop and have another go later on [laughs quietly]
> JE: ...Why is it that you can't stick with it?...
> S: [...] it's not usually related to something that I want to know. Say, for example, psychology - I cope with the maths because I'm interested, I want to find out something through it via it, therefore I'll stick with it a lot, lot longer than just maths on its own ... [2 lines]... If I need it, I'll just use it, but otherwise I just don't want to study it as a subject. (p.3; both emphases his)

This appears to be a clear statement that he doesn't have any strong feelings - and certainly no "worries" - about maths. Another "statement" about maths follows Qu. 3 [changes in the price of gold, over a day's trading]:

> JE : Right, does that remind you of anything, anything you do these days?
> S: Not particularly, no - I wouldn't use that, wouldn't look at it, wouldn't be interested in it, [3 sec.] unless I was interested in gold [laughs] ....
> (transcript, p.5)

For Qu.5 [9% wage rise on £66.560], his response to part A ["approximately?"] - "roughly about £6" was very close to the exact answer. His response to part B ["exactly?"], after a 15 second pause was: "No [I couldn't tell exactly]... I'd have to look it up again" - in what he calls his "comprehensive" maths textbook (p.8).

In response to my question as to how he would decide which jar of mustard or relish or jam to buy if he had a choice in the supermarket, he replies: "Usually, the taste comes first, and then the money....". When I ask which of the two bottles depicted for Qu.6 he would buy, he points to the larger, but admits:

> S: ... I haven't worked it out [laughs] {inaudible} ... [5 lines]) ... you just presume that the bigger one is cheaper [...] ... It's not the sort of thing I'd work out unless I was [...] living on my own, [...] if I was short of cash; but as I don't normally buy the food, I'd just probably buy that [the larger jar] presuming it was cheaper. I wouldn't bother working it out and spending the time ... the time's more valuable to me than the money at the moment ...[3 lines] sometimes my parents go away, so I have to buy my own shopping; it's not usually my own money, it's usually theirs [laughs] ... [4 lines] ... I don't spend too much time working out, I just get what I want....
> [10 lines] ...
> Sometimes, it's the sort of problem that does come up in mathematics - in O-level or CSE [...] In that case,

> I would spend time trying to work it out, in the correct manner [...] But at the moment, I'd probably be pretty lazy [laughs]
>
> (transcript, pp.10-12)

Alan also seems to have a clear idea of the difference in approach required in the different activities of shopping and school maths. In practical problems, he is more calculating about time - and effort - than about money. This is perhaps heightened by its being <u>his</u> time whereas the money is provided by <u>his parents</u>, through the family routines described in the quote above, which are in turn based on family discourses about the spending of money. Here these discourses are based on a solid material foundation of plenty, and a lack of constraint: "I just get what I want" !

School maths problems, on the other hand, need you to "spend time" on them, "trying to work it out". This might help to explain why he was one of the estimated 5% of students who did not get beyond Qu. 20 in the questionnaire performance scale - he was "spending time" on questions which he perceived to be SM. (Recall that, of the 18 questions he actually attempted on the questionnaire, he made only one mistake, a slip.)

When we look for feelings, especially anxiety or a lack of confidence, <u>expressed</u> about maths, it is difficult to find anything. For example, he claims to feel basically neutral about the interview :

> S: ... So, I was pleased with the interview...
> JE: You didn't, did you find it nerve... -making?
> S: No, initially with the tape recorder there, I think it did increase my nerves a little bit, just - yes it did - otherwise, no.... (transcript, p.13)

This is the only point where he gets at all close to <u>expressing</u> any anxiety in the interview - and it is rather restrained! Because he was the only subject who was asked such a leading question about his feelings in the interview, and since, in any case, what he expresses is ambiguous, I coded this as "EXP - (?)" - i.e. anxiety not expressed (but not certain).

However, there are several indicators that may suggest unacknowledged or exhibited anxiety:

- the insistence behind the two "statements" quoted above, e.g. the emphasis on being "very neutral" in the first, and the repetition in the second;
- the frequent laughter, sometimes nervous;
- the slow manner in which he answers many items, e.g. almost 40 sec. to answer both parts of Qu. 3 (p.5), parallelling his apparent slowness on the Performance Scale of the questionnaire (see above);
- perhaps even the fact that he "can't concentrate" for long on maths.

Rather than expressing anxiety (as do Fiona (sometimes) and interviewee no.1, another woman), or fear or panic (as do Donald and no.8, another man), or worry (as does Jean), or blockage (as do nos. 2 and 4, both men), or confidence (as does Ellen), or any feelings at all, this student claims to be "very neutral", without "any strong feelings" about maths (see the quote from the first statement (p.3) above). It's just that he "can't concentrate for too long".

Thus, to summarise, his performances on the questionnaire and in the interview are fairly competent, if sometimes painstakingly slow. He seems lucid about the need for "mathematical" calculation in various practices: if necessary, he will "spend time working it out, in the correct manner", but otherwise he will probably be "pretty lazy", since he doesn't really want to "study (maths) as a subject". (NOTE 13)

Finally, he claims to be "neutral" in his feelings about maths. But he is fairly forceful in asserting his neutrality, and repetitive. Is he perhaps "protesting too much"? For a deeper level of analysis, we can begin with his statements about his "neutral" feelings towards maths. These contrast strikingly with the ways in which he may be <u>exhibiting</u> feelings (see above). He seems to be defensive, perhaps to be trying to control strong feelings.

He certainly seems to be concerned with control in some senses. He has a "comprehensive" O-level maths textbook there when he needs it, whenever it is a question of a maths question which he doesn't how to do (p.8). It may thus serve as a defense against anxiety. (NOTE 13a) As a routine, his parents do the shopping, and leave him money to buy whatever he needs when they go away for a week. Also, when I ask what would be the best arrangement of the course for him, he would like "an hour per week of individual attention" on demand (p.12) - that is, under his control - or else "my mind will just wander off" (p.11). Here is "can't concentrate", again!

Let us look more closely at his inability to concentrate. In the first "statement" quoted above, he allows that he has "difficulties" in maths and "I can't concentrate for too long on maths ...." In the next part of the statement, he continues: "If I need it, I'll use it, but otherwise, I just don't want to study it as as subject." That is, "can't concentrate" has become "won't concentrate". Could what seems at first to be a carefully reasonable and coherent argument turn out as an example of <u>rationalisation</u>?

We have noted above the basis on which Alan makes a trade-off between time and money: "The time's more valuable to me than the money at the moment...." This contrasts with Fiona's views - perhaps quoting her father: "Time is money, money is time" and "I've been taught from an early age not to waste money". Their views seem to be the mirror images, in some respects, of each other. For Alan, time is more valuable than money, perhaps because he has been given some amount of access to his parent's money - which allows him to get what he wants. For Fiona, on the other hand, while the first quotation above is even-handed between money and time, the second seems to focus on, and thus give priority to, money. This may relate to her feelings about not having been given free access to her father's time, or money, or, she may feel, affection. These different ideas may reflect different social class positions, for example, to different fractions within the middle classes.

This interview allows me to explore a number of themes, including:
- a closer look at an apparently "typical man", who describes himself as "neutral", without feelings about maths in the interview; and
- the use of psychoanalytical insights to understand such self-reports of "no feelings" about something, and being "unable to concentrate".

11.2.6 Donald

Interviewee no.10, Donald, was male, 47 years old at entry, with an O-level equivalent in Maths. The background of his parents was working class; his own was middle class, having worked on the money markets in London. He was now on the Town Planning Track.

Reflexive account: This student was a member of my Methods and Models maths seminar group, which worked exceedingly well, in the first two terms. He was satisfied with the group, I think, and was interested in the philosophical aspects of mathematics. (The Methods and Models course comprises mathematics and philosophy of science strands.) Having originally entered for Social Work, he almost switched to Philosophy during the first two terms. I was pleased when his name came up in the sample (and said so in the interview). He came up to fix a time after a lecture, and took the first slot.

On the questionnaire, his performance on the items classed as school maths was 9 of 10 correct, and 9 of 12 items classed as practical maths, for a total of 18 correct out of 22. The two PM answers marked wrong - Qu. 14 on inflation: "prices would have gone down" and Qu.18 [10% tip on £3.72?]:

"37.2p" - were odd for someone with his work experience - though the second was also made by Ellen and Peter, and neither error was rare in the whole sample (see APPENDIX R4).

His maths anxiety responses on the questionnaire were exceedingly low - around "relaxed" for the averages on numerical anxiety and on maths test anxiety, and between "relaxed" and "fairly relaxed" for the measure of general anxiety used. Thus he is in the 2nd decile for NA and in the 3rd percentile (!) for maths test anxiety. (Most of the individual items he rates as 1, 2 or 3, all varying degrees of "relaxed", as compared with Alan, who used mainly 4's, "neither relaxed nor anxious". (NOTE 14)) Nevertheless, he illustrates a "very good fit" to the inverted U relation between school maths performance and maths test anxiety, since the residuals are very small (less than 0.1 of a question for both models for PERFS; see Sec. 6.3).

In the interview, he attempted Qus. 1 to 4, all done in his head, all "correct" - except for Qu. 3B [lowest price on graph of gold price] (see below). For Qu. 1 [reading a pie-chart showing water use by various sectors of the economy], in response to my question about "any sorts of earlier experiences with numbers that it reminds you of, or feelings it brings up", he replies:

> S: No, nothing comes straight to my mind at <u>all</u> ...
> JE: Okay. Do you remember those from school at all, or from work?
> S: I find it very difficult to remember school at all - not only just school, but anything in my childhood really, so ... I know I didn't really understand maths [3 lines] ... I couldn't see the point of it at all - to my <u>real</u> life, you know....
> JE: What were you mainly interested in those days?
> S: Literature ... [JE: 2 lines] ... Oh, Shakespeare, Bronte sisters, and - I read a lot of books, I read escapism books...
> JE: Any particular favourites there?

S: I remember the first book I read was a book called Red Cloud, about mid-Western America, chasing buffaloes ....

JE: That's pretty good memory.

S: Yes, I wanted to be with them, I'm sure...

(p.5, his emphases)

Here we have a contrast between school, of which he can remember nothing, and his "escapist" reading, which comes back with a striking clarity, after thirty or more years.

In response to Qu.3 (a graph showing how the price of gold varied over one day's trading in London), he begins by calling up business discourses, or what might be called "money-market maths":

JE : Does that remind you of anything that you do these days, or you've done recently?

S : Er, some of the work we done in Phase One [the first two terms of the College course], but if you ask me straight out of my head, what it reminds me of - I worked once with a credit company and we had charts on the wall, trying to galvanise each of us to do better than the other (JE: uh huh), and these soddin' things were always there and we seemed to be slaves to the charts... [2 lines] ...I found it impossible to ignore them, even though you know that they're just getting you at it.... [2 lines] ... That's what that reminds me of - a bad feeling in a way - I felt that a human being was being judged by that bit of paper...

(transcript, pp.8-9; his emphasis)

Here we notice that Donald is reminded both of his "College maths", and of his earlier practice of managing a sales team - but it is the latter business practices which he actually is seen to call up.

Next in the same episode, he mentions college maths, then seems to link "work maths" with it.

JE : ...Does it remind you of Phase One?
S : Yeah, well, we done some of the questions like this, and er, the run over the rise and that kind of thing...[5 sec.] ... trends, I suppose if you were judging a trend ...
[2 lines] ... I find good, I like the fact I can do a chart now (JE : uh huh), but [...] I couldn't sit down and do it straight away ... [2 lines] ... With maths I have to go back to the basic things all the time....
(transcript, pp.10-11)

Here he uses the language of College maths, describing the gradient as "run" over "rise". He then shifts into work discourses, as evidenced by his use of the terms "trend" (rather than "gradient") and "chart" (rather than "graph"), which were not used in the college teaching. We now need to consider whether what appears to be an ability to translate elements between discourses will help in performance. In this second quotation, he has described the gradient as "run" (X2-X1) over "rise" (Y2-Y1) - whereas it is the inverse! At this stage it is difficult to know whether this is due to a memory slip, or to a more basic misconception. Next I ask specific questions about the graph.

JE : Right, okay, may I ask you which part of the graph shows where the price was rising fastest?
S : If I was to make an instant decision, I'd say that one, but obviously want to make it on a count of the line, wouldn't I? (JE: You'd?...) I'd count a line (JE: Uh huh) as it goes up... [25 sec.] ... eleven over six and ten over six, so that one's right - in the first one [i.e. before lunch] ...
JE: ... [2 lines] And um, what was the lowest price that day?
S : This one here - five hundred and eighty [...] went higher at the close, for some reason...
(transcript, p.12)

Here we note that, when asked to compare the gradient of two lines, he makes a perfectly accurate "instant decision", possibly drawing on his work experience. However, he feels impelled to "count a line", which I take to mean: calculate the gradient by counting squares on the graph, as in college maths. There he gets the correct answer, confirming his earlier decision based on work practices - and confirming that he can use the formula for gradient correctly - though his calculations are approximate. So too is his reading of the lowest price - which should be $590, not $580 (see see the discussion of Qu.3 in Sec. 10.3). At the end of the episode, he is back in the "money market" practice, as shown by his speculating about why the graph "went higher at the close". Here he has displayed what may be a basis for <u>translation</u> between the discourses of school maths and what might be called "money market maths".

Thus, my <u>1st reading</u> of his misreading of the lowest point on the graph is that it was just a "slip". It must be admitted that the photocopy of the graph was not perfect, and also that nine of 23 subjects slipped up here. However, there remains something slightly surprising about his slip on <u>this</u> question: we might have expected some "transfer of learning" from his work practices - familiarity with charts" - to college maths - familiarity with graphs. Might these slips have something to do with the range of feelings he has expressed in these two episodes?

As for affect, in the main episode above, he ranges between "good" and "bad" feelings. He again expresses mixed feelings about work later:

> S: Once you're in there you do perform - you wouldn't do a bad deal in a million years 'cause it's yourself's on the line ...
> [5 lines]
> JE: ... that sounds like pressure, doesn't it ...
> S: Oh, dreadful!
> JE: ... did you feel the pressure or the anxiety?
> S: Oh, very much so, yeah ... Sometimes I got a pain in your chest [2 lines] - you had, the form gets stuck to your hand, the tension, the sweat.... But once you do a

good deal - somehow, it could kill you somehow, you just feel good or something, as if it's your own money... (p.14)

But he expresses confidence about his numeracy at work: "I'd no confidence with figures when I started [work] ... sheer use made me good at them" (p.7). But now "I can read figures ... [2 lines] I just had a gift for that ... "(p.6).

He also expresses a range of feelings about academic maths. He tells of his new-found positive feelings for mathematics:

> S: I found connections of something there to go from one thing to another, and I found it [maths, during the 2nd term] exciting, you know, I couldn't get bored with it at all.... [2 lines] ... I liked it.
>
> (p.15)

But these new feelings are still tentative. He is "not [..] afraid of figures , but the formulas and things still frighten me really ... (p.15, my emphasis). He also describes an experience of feeling a "block", when he first attempts the current Maths worksheet - followed by "panic":

> JE: Panic, uh huh. So when you look at a question, what happens? ... [1 line]
> S: Some kind of inferiority inside of me says I can't do it ... My brains tell me I can do it, but something says I can't...
>
> (transcript, p.17)

The only examples I can find of anxiety (or lack of confidence) possibly being exhibited about maths are the two slips on Qu.3 already mentioned. If we check the anxiety scales on the questionnaire, there is no item which refers to graphs, and only one which mentions formulae. But on Qu.15 on the "Experience" Scale (the basis of the confidence variable - see sec.4.2.2), he rates himself as "very capable" in all areas of basic maths - except for algebra and graphs. To Qu.18 ["anything special you would like to learn about Maths ... this year?], he writes: "practise with graphs". Thus a 2nd reading of his slips on Qu.3 is that they may relate to a chronic lack of confidence about graphs and algebra, as reported in the questionnaire. Can the interview shed any further light on this?

His expressions of anxiety and lack of confidence have been quoted above; e.g. "... the formulas and things still frighten me really ..." (interview transcript, p.15). Here we need to consider the context, the positioning, within which he addressed Qu.3. For this problem, Donald was considered to call up predominantly money-market maths (i.e. business discourses) - along with no.9 (ex-stockbroker), no.21 (ex-manageress), and Fiona (see above and Sec. 10.3). And all four made an error in reading the lowest point on the graph. At the end of Sec.10.3, it was suggested that, in money and business practices, the readings of graphs are regulated differently, since they are made for different purposes - e.g. for rough comparisons, rather than for precise individual readings. This view would provide the basis for a 3rd reading of his slip in Qu.3: addressing the problem within a "practical" discourse, rather than within SM, reduces the need for precision.

Donald makes a distinction between different "aspects" or "types" of mathematics which is similar to those made by a number of other subjects; see for example the discussions of Jean's and Peter's interviews in this section. He appears to distinguish (NOTE 15) between what might seem to be two different "types" of mathematics, school maths and a particular kind of practical maths, but these occur in different contexts and are marked by a range of different feelings. For example, "...banking and figures were a job, or something, but maths were there to trip me up or something..." (p.15); and "... I feel - not afraid of figures - but the formulas and things still frighten me really ... (p.15, my emphasis).

This is related to the fact that at school "these things were splashed up on the board, and nobody said what the hell the reason..." (p.21). For Donald, "till I get it into my head what it [i.e. a formula] means, I'm not happy ..."(p.22, my emphasis). He also finds the formula frightening, because "it's divorced from reality in my mind" (p.21). Also, "I'd get an answer to pass an exam, but I'd no idea what it was all about. I [...] couldn't see the point at all - to my real life, you know... " (p.5, his emphasis).

Thus we can see that Donald uses a deeply felt distinction - between "figures", on one hand, and "formulas and rules", on the other:
which relates to work (maths) vs. school / college maths;
which relates to figures being "a job" vs. maths being "there to trip me up" (p.15);
which relates to being meaningful /"having a point" vs. being "divorced from reality";
which relates to confidence vs. being "frightened";
which relates to "feel(ing) good (about numbers)" vs. "a bit of panic" about "formulas and "rules" (p.23).

Returning to his first slip on Qu. 3, which involved inverting the formula for the gradient as "run over rise", we have now seen that he is "frightened" and in "panic" over formulae in general, so it is no wonder that he suffered a "memory slip" on this one here. This relates closely to the second reading, which explained the slips by his chronic lack of confidence about algebra and graphs.

Let us reconsider several issues, using insights from psychoanalysis.

I. Most striking is his finding it "difficult to remember school, ... anything in my childhood really" (first quote above). The memories appear to be repressed. This may be related to some earlier experiences with maths in particular: he has "an inferiority" about mathematics (p.11, p.17); and "I was frightened of maths really" as if "maths were there to trip me up" (p.15). It may also have something to do with his anxiety about a lack of control generally in school, compared with his good feelings about literature, especially "escapism" books (p.5). It is of course difficult to be sure what the basis of this amnesia might be: if this interview had been part of a series, rather than a one-off, this would have been an area to pursue systematically.

II Fantasies provide a site where the subject can be in control, and Donald produces several. Reading "escapist" literature led for example to a desire to be with the buffalo-hunters in the 19th century American mid-west (see first quote above) - which is pretty far away from school in 20th century Europe. At the end of the interview, when we return momentarily to discuss Qu.2, he recalls:

> S: ... in the shop [...] my mind just would make prices up ... [2 lines] ... If say { inaudible } somewhere, say, reduced by 15%, I could do it in my head without thinking, almost.
>
> (transcript, pp. 20-21)

Thus he clearly had insistent fantasies involving making up prices, and calculating discounts in shops. Could these have been on goods which the young Donald desired, but his family couldn't afford?

III. When he goes to work, he gets into selling money, where it sometimes feels "as if it's your own money" (p.14, in the context of feeling good after doing a good deal). This practice, and the figures etc. may relate to deep fantasies; e.g. it is exciting to play with money. They may also be a defense against a deep anxiety about not being in control, about not having something. So far in his life, school maths has failed to relieve this set of anxieties for him - in contrast with those boys attracted to the "mastery of reason" (Walkerdine, 1988) - though it is interesting to note that college maths has given him a taste, and he now feels that it would be "exciting" to do a maths degree at the Open University (p.11). Thus, he has different affective "investments" in school maths and "formulas", from those in his money-market practices and "figures".

IV. Returning to slip on Qu. 3B, it involved his reading the lowest point on the graph as $580, less than the correct value of $590. We can recall that he says that the graph reminds him of "a bad feeling", and of how he "found it impossible to ignore" the graphs showing his performance on the wall (transcript, p.7). Is it possible then that his misreading of the graph might be motivated by his desire to ignore such "charts"? Though admittedly only <u>very</u> suggestive, this <u>4th reading</u> may provide the affective / psychic basis for the chronic lack of confidence about graphs, the basis of the 2nd reading.

This particular case study allows me to draw out some ideas about what <u>familiarity</u> with a discourse might mean - using this subject's talk about his contrasting experiences and feelings about work in the money markets, and on school maths. Most of the examples are from money market practices, with which he still feels much more familiar than with those of mathematics. Familiarity seems to include the following aspects:

(i) It requires <u>knowing the language</u>: see the discussion of the episode related to Qu.3 above, where Donald illustrates the importance of this when he solves the problem within both business maths and school maths discourses.

(ii) It involves the <u>memory</u>, even when that is not necessarily helpful cognitively: e.g. "It is an ego job, I can remember every bad deal I've done" (p.3).

(iii) But you must also have a "<u>feeling</u>" for it (cf. Carraher et al., 1986; Gabony and Traxler, 1984; Willis, 1984):

> S: ... I had a gift ... [2 lines] ... I could run down the columns and [...] I know what I'd be expecting and if something wasn't right, I'd say there's something wrong there ... Not always, but I had a feeling for it, I had a feeling, I just let my feelings go - more than

my, more than anything really.... (p.6)

(iv) Part of this feeling is having an idea of the possible "solution shape" (cf. Lave): e.g. his "expecting" a figure in a certain range (see quote above). Other examples come from various subjects' being "critical" of originally erroneous or implausible answers to Qu.5 (see sec.10.4(b)) - and by Ellen, who rejects her calculated tip for Qu.4, because she "just saw ... that it was far too small".

(v) And the feeling may sometimes be "intuitive" or subconscious: e.g. "You didn't have to think about it [...] you took a chance [...] and you were right six times out of ten..."(p.3); and "When your intuition is good, you can smell it" (p.13).

(vi) Familiarity may be developed by repeated exercise: e.g. "It took me time to get it, because I'd no confidence with figures when I started, but ... sheer use made me good at them" (p.7).

(vii) Familiarity may be related to confidence: e.g. "... the things I know I'm good at and can do - like columns of figures ..." (p.21). However, it may be related to bad feelings, as with the "charts" at work, or perhaps to mixed feeling, as in this case.

(viii) Familiarity may be developed within relationships with positive affective charge (Scribner and Cole, 1973; D'Andrade, 1981). However, Donald recalls that "In business, most people are very jealous of their expertise, and sometimes they don't want to pass it on to you...." (transcript, p.7);

(ix) Familiarity with something involves seeing it as meaningful or appropriate for yourself, as not alien (Murphy, 1989). Donald distinguishes Maths during his time at school from "my real life" in the first quote above (transcript, p.5). This idea of distinction between "different types of mathematics" is shared by a number of students (see Sec. 11.3).

It can be seen from this characterisation that "familiarity" has aspects which can be seen as largely affective - e.g. (vii), (viii) and (ix) above, as well as some largely cognitive - (i), (ii), (iv), (v) and (vi), as well as some aspects which clearly straddle both - e.g. (iii). Thus "familiarity" plays a crucial straddling role in attempts to consider the cognitive and the affective as part of one whole.

Finally, we can note that Donald's fear of mathematics has "changed as the time went on": he finds "connections" in college maths - the Polytechnic's 1st year course ("Methods and Models"), and finds this "exciting" (p.15, quoted above). That is, he is beginning to have a "second chance" with mathematics, as are some other interviewees. In his case, the basis of the second chance is a college course that seems to be very appropriate for him.

This interview allows me to explore a number of themes, including:
- an illustration of the meanings of "familiarity" in the contexts of numerical work;
- another illustration of the "classification" of numerate activities into types;
- the relevance of social class background, and level of material affluence; and
- illustrations of the meaning of fantasy.

11.3.7 Peter

Interview no. 19, Peter, was male, 20 years old at entry, and from a middle class background. He had passed O-level Maths and was specialising in Economics.

Reflexive account: I had not taught Peter in the previous two terms, nor even met him, as far as I could recall. When I wrote inviting him to interview, he replied, indicating his willingness to attend; but he then did not respond in writing to my offer of a time. Then he did show up at the time I had originally offered him, meanwhile booked for interviewee no.25. When she did not show, we began the interview at 11.15.

On the questionnaire, his scores were 9 of 10 correct on school maths items, and 7 of 12 correct on practical maths items. For Qu.18 [10% tip on £3.72], he answered "37.2 p" as for example did Donald and Ellen (see also Sec.5.2). His anxiety responses were around "4" ("neither relaxed nor anxious") for maths test anxiety (TA) and around "3" ("fairly relaxed") for numerical anxiety and for general anxiety. On all three scores he was thus close to the median for the whole sample (cf. Alan who was close to the middle score ("4") on all three scales.) He illustrates a very "good fit" to the inverted U relationship between school maths performance and TA (with residuals of almost 0 for the two PERFS models - NOTE 7).

He begins by telling me that he had to keep taking O-level Maths until he passed it on the third try: "So I was [..] under a little bit of pressure ... [at his grammar school]" (interview transcript, p.3). He then explains how he came to be taking Maths O-level:

> S: ...See, my father's an engineer and all of my brothers, bar one, are teachers - and I was not pushed, but I was gently persuaded, in the area of taking sciences at O-level, then another two sciences at least at A-level, going on and doing some kind of teacher training degree like, probably in something like physics [..], hoping for an easy job at the end - not an easy job, but an easily attained job - so, you know, I was always pushed towards taking Maths at O-level and A-level, and also Physics at O-level and A-level., and unfortunately I just didn't master either of them....
>
> (p.3, his emphasis)

Being the youngest of five sons in such a "mathematical family" can be a mixed blessing - especially when it comes to "homework" - the activity par excellence which involves inter-discursive positioning across family and school practices:

> S: ... my father's [..] very good at maths - which is a shame really because he's always tried to teach me, and I just couldn't ever have much success [...] ... to get me through my O-levels, both he and my oldest brother almost constantly tutored me in my homework and everything... And my dad is the sort of person who will, if you ask him a question, instead of giving you straight answers, he says - well, hold on a minute, I'll go and find a book - and there's another book, and then another book, and hopefully a five minute explanation turns into a half hour looking through [books] - and you're getting a very complicated explanation. And I found from that I don't think I was ever really interested in mathematics....
>
> (p.4)

Being tutored by his oldest brother - himself a qualified maths teacher, was even worse:

> S: ... if I didn't get anything right, then it was, it was even more you know, lecturing and er, you know, sort of, not exactly saying that I was stupid, but getting onto the old intelligence bit - so I suppose I became a bit scared of maths in general as a subject as well as physics, and as I say, it was a relief to take something else as non-numerical, or easy to grasp, as Law or Economics or History [subjects he did at A-level] (JE: right, sure) - there are numbers involved, but they're just not forced on you in the same way, or not quite as {"quickly"?}.... And I never really found mathematics in economics hard to handle.
>
> (p. 5, his emphasis)

Thus, Peter makes a distinction between Maths / Physics and less numerate subjects. First, the maths used in Economics is not "hard to handle" since he can understand the symbols, e.g. "T for taxation, I for income [sic - it should actually be 'Y']" (transcript, p.5); this differs from algebra where, in his view, there is "no excuse to make up symbols to replace something with [i.e. which has] an actual reality" (p.6). Second, after being "pushed" to take subjects like maths and physics at O-level, it was a "relief" to take "non-numerical" subjects like Economics, Law and History at A-level: they are interesting and useful - unlike Maths (see above).

There are some differences in the working habits he deploys. Though he mentions appreciatively that you can look up a date or a statute in a (History or Law) book (p.6), he seems resistant to doing the same thing in Maths, when he misses a lecture and doesn't understand something (see p.6, p.7, and also p.8). Later he makes a statement about what he has to do when he doesn't understand something in Maths - "think about it [..] - but I don't reach for a book!" (p.16). Of course, this may have a lot to do with the way his father used books, when this son asked a question (see above).

He has a number of "difficulties" with Mathematics in particular. He loses concentration often (p.5). And he often finds things don't "stick in his mind" (e.g. correlation, p.8). Nevertheless, he hopes to "master the approach" in his 2nd year maths option for economists (p.8; my emphasis).

In the interview, when I ask him to try some questions, he is somewhat resistant, and tells me about a recent job interview:

> JE: ...if I give you a few questions to try. Would you be happy about that?
> S: Well, reasonably ...
> JE: Reasonably ...
> S: Yes, I've been to a couple of job interviews where there's been some pathetically easy sums on a piece of paper - but because they've been on a sheet, set out in front of me with someone looking over me, I haven't

been able to do them (JE: yes). I think that' something that's come from having been taught by my father in that way...

(transcript, p.10)

For Qu. 2 [10% of 6.65], Peter offered two methods - both working from first principles, reconstructed as (a) and (b):
(a) 10% of 665 = 66.5, so move decimal point 2 places, so .665; and
(b) 10% of 1 is .1; 10% of 6 is .6; 10% of 6.65 is .665.
He began with (a), then seemed to become confused, and moved to (b), then seemed to decide to move back to (a). He explains:

> S: And I try to do it from either end, to make it as easy as I can, without just doing the problem straight off.... (JE: right) - 'cause I can't usually do it straight off... [3 lines]
> ... percentages [..] at secondary school [...] was one of the things I was able to do, and you can work it out on a piece of paper, if you want [...] ... I prefer to work things out in my head [...] particularly with maths...
>
> (p.15)

Here "doing it from either end" seems to mean that (a) involves "magnifying" the original number so that there are no decimal places - viz. 6.65 to 665, taking the answer from 10% of the latter, and "reducing" it correspondingly. Method (b), on the other hand, is a type of "decomposition" (e.g. T. Carraher, 1988), which is especially suited for mental calculation - which he insists on doing, for the reasons given here.

Two aspects of his performance are especially interesting. All of the answers are correct - despite his laborious procedures for Qu.2 and despite his resistance to attempting the problems in the first place. And all the questions are done in his head - not what is expected from someone positioned predominantly in SM, as he was for most of the interview. (NOTE 16a) At the end of the last quotation, he gives some insight into why:

> S: ... maybe people can't see what you've, what's going on in your head - and they can see what you're writing on a piece of paper ... (p.15)

For him, being observed signifies being regulated, pressured, "pushed" by his father (and brothers), while not being helped very much by them. Not surprisingly, there are no traces of calculation evident on his questionnaire - unlike, say Alan or Donald. This shows that mental methods do not necessarily preclude a school maths positioning - and recalls the point that written methods do not necessarily indicate a SM positioning (see e.g. Sec.10.4(b)).

Peter also gives two unsolicited "performances" during the interview in what seem to be practical maths. The first followed Qu. 2 (when one of his laborious solutions involved a form of decomposition):

> S: ...I've always thought - well, how would I cope working behind a bar, when you have to add up a round and I'm always left doing it in my head, and I do [...] whole numbers first... 65p plus 50p plus 20p, then I would do sort of 60p + 50p + 20p + 5p ... much easier if it's a more awkward number like 68 or 64 or something ...
>
> (transcript, p.16)

Interestingly, this strategy also involves decomposition (though he doesn't show that he is aware of the parallels between the two approaches). The second "display" comes up when I present Qu.4 [10% tip]:

> S: ... Well, just adding up a full meal would be [...] coffee [27p] and the chicken [£3.75] ... would be {20p?} £4.02. (p.18)

Both of these performances - that working behind the bar and that in the restaurant - are based on imagining a situation which he is rarely or never in, and then performing competently in it. The bar example does not, however, give a particularly convincing example of the power of decomposition for mental addition (NOTE 16); the restaurant example, if the partially inaudible "20p" is correct, would be better.

However, towards the end of the interview, when I ask how he feels "about the way you're able to use numbers in general these days" -

> S: I think I'm alright, as far as I can see, I'm okay using numbers in my head. I find I'm far more comfortable [...] working out [...] my gross handicap [in golf] in my head, rather than having to put it down on a piece of paper. Or if I'm playing darts ...
> [3 lines] ... But it gets [...] worse the more I have to write things on paper.... And I find the first time I do a sum, I hate it; and the second time I do it, it's not quite so bad... And as soon as I've actually figured out the simplicity involved in it, and finding out how actually, how simple it really is - once I've done that, then I'm all right, I'm coasting ...
> (pp.19-20)

Peter expresses confidence in these examples, which are much more convincing than the imagined examples he gives earlier, because these relate to activities in which he actually engages. The second part of the passage seems to illustrate a sort of accomplished, if limited, "mastery" in his "coasting". Note that he earlier gave examples of lacking mastery, e.g. in O-level maths or physics (p.4, quoted above), or in the job selection interview (p.10, quoted above).

He has earlier expressed a great deal of anxiety about maths in general; for example, after his brother's "help" with homework, "... I suppose I became a bit scared of maths in general" (p.5; quoted above). And at school, "I seem to remember in my first year of secondary school having long multiplication questions, and not being able to do them, being scared out of my head at being marked...." (p.12). He also exhibited lack of confidence about maths at several points - perhaps most notably in his resistance when asked to try some problems, which is related to anxiety shown by his telling the story about his job interview, to which he returns again later in the interview:

> S: ... on this job interview, they had a string of long multiplication sums and then next door to that, they had addition sums in the same format, and then subtraction sums in the same format, and it was a very bad photocopy, and you know you couldn't see the signs, so I multiplied them all (JE: uh huh) - and then obviously got two-thirds of them wrong...
> JE: Oh, that was at the job interview, oh that's a dirty trick, I think, if it's a bad copy... (S: yes) Did you tell them that?
> S: [..] about two inches above the sums, it had a title, y'know, and "multiply" underneath, "subtract" underneath, and "add" - but because I was looking at the sums and not at anything above, I didn't see it... [S inhales and laughs ruefully.] So I got the questions wrong, and it was for a shop [a national chain], and I didn't hear from them again...[S again inhales and laughs ruefully.] ...
>
> (pp.18-19)

Note that his failure to read the instructions carefully for the maths problems in the job selection test is mirrored by his not reading Question 1 carefully in this interview!

A range of feelings is expressed in the following story about "daydreaming at school":

> S: I remember [...] in math lessons being caught day-dreaming [...] And then I would have to [..] admit that I wasn't paying any attention... [4 lines] ... I

> think that was something that was unique to maths lessons, y'know [...] being asked questions and not knowing the answer, and ... being very, very - first of all, you know, embarrassed and ashamed - and then a little bit angry at being asked a question in the first place. What am I doing here, y'know, sitting in front of these useless numbers? - they'll never be any use to me - and why would I want to know how long the side of a triangle is?
>
> (p.5)

This chain of feelings - embarrassment, humiliation, anger, leading to resistance - is not uncommon in my experience as a teacher.

To summarise, the main affective themes in this interview. Peter expresses and exhibits some amount of <u>anxiety</u> and lack of confidence, as well as some confidence - plus some attempts to display what seems to be ultimately a somewhat specious confidence. He experienced <u>pressure</u>, in being "pushed" towards maths and physics by his father and brothers, and towards doing O-level Maths by the school. He thus has developed a <u>resistance</u> to maths, based on a whole range of negative feelings grounded in earlier experiences with tutoring at home, and at school. He gets "relief" (from anxiety, from pressure), by a few topics within maths e.g. pie-charts (transcript, p.12), and by relatively "non-numerical" subjects, such as Economics, his chosen Track on the degree. Finally, he experiences a seeming "mastery", or at least relief, from practising a "sum", and from "figuring out (its) simplicity" (p.20).

For a deeper level of analysis, we need to explore what he means by mathematics and "mastery", the resistances he has to mastery, his anxieties, and how they relate to his social class positioning.

In this family, being able to do mathematics seems to signify intelligence, and rationality, for the father and five sons at least. For example, his father puts a lot of effort into _knowing_ about mathematics. And if Peter made mistakes, his older brother, trying to teach him, "would get onto the old intelligence bit" (p.5).

Peter is certainly the interviewee who mentioned "mastery" most often. (NOTE 17a) It eluded him in maths and physics at school, but he hopes to "master" the approach used in the maths option for the Economics course he has just begun. He describes two situations where he is in control of whatever comes up for him - from the customers in the pub, or from the menu in the restaurant - but these situations are _imaginary_: he is not actually involved in these practices. There is some amount of _fantasising_ here.

However, at the end of the interview, we get a glimpse of possible mastery: he refers to repeating a sum to the point where he has "figured out the simplicity" involved in doing it, and he is "coasting" (p.20). But what sort of "mastery" is this? He rejects the way symbols are used in algebra (see above). His vision of what he lacks seems to be the grim sort of mastery possessed by his father, struggled for over long years, and needing constant updating from books. For Peter, the "coasting" he desires seems more like "relief": he is unlikely to feel pleasure, as do some of the boys in _The Mastery of Reason_ (Walkerdine, 1988), or even as Harriet does in reclaiming, tentatively, her ability in school maths.

Furthermore, though he fantasises about mastery, about success, he sometimes actually engages in actions of _resistance_ which militate _against_ success; this shows considerable ambivalence. It also leads to his appearing incompetent, useless in maths - whereas he has developed some useful insights (e.g. via decomposition - see above). This resistance seems to have been produced against the _pressure_ on him from home and the school (see above). These pressures have produced a chain of negative feelings for him to deal with, e.g. in the story about "daydreaming at school". He seems to deal with these feelings by resistance, not by going for mastery. The interview provides examples of his resistance to mathematics - not reading his father's books, not looking up textbooks for 1st year maths, not attending lectures on time, losing concentration, etc. But he also seems to resist reading the instructions on the test at the job interview - and also the questions given in this interview; e.g. for the pie-chart in Qu. 1 (see above).

In the story about his failure in the job interview arithmetic test, he exhibits a large amount of anxiety: it is the sort of situation in which he becomes "a bit [sic] confused" (p.19)! He explains this as due to the sums' being "set out in front of me with someone looking over me" (p.10), and makes a connection between the job interview, and his sessions with his father doing maths homework.

He also seems to connect the sessions with his father with doing problems for me in the interview. When I ask if he would be happy about "a few questions to try", he responds "Well, reasonably...", and then immediately tells me the first part of the job interview story (NOTE 17). Thus the anxiety seems to flow from the homework sessions, to the job interview, to the interview here. And his resistance in these situations seems an attempt to avoid, or to manage, anxiety.

We might use the term "transference" to explain Peter's unconscious reaction to me as interviewer, as he is imposing childhood images onto an everyday "object" (Hunt, 1989). He also does the same with the tester at the job interview. Transference might also help to explain the perhaps "provocative" frequency with which he mentions missing 1st year maths lectures, some of which were given by myself (see pp. 6, 7, 8). The idea of transference helps to explain some episodes in the interview, and in Peter's life, that might be difficult to explain otherwise.

Peter presents his father as anxious for him to know, especially about mathematics. In this sense, he is like Harriet. However, unlike her father, who does not assume that he can know, Peter's father not only expects the son to know, but expects to know, and does know, himself: what you do is - get out a book. But Peter's father still seems a bit anxious himself, as is shown by his always wanting to look things up in books, and needing to give long explanations. Peter is fairly clear on why: his father had an unconventional, drawn-out engineering education, and always needed to keep up with the new ideas; also, "he just likes to explain things very methodically and making sure he gets everything right before he tells you something, instead of jumping in at the deep end..." (p.5). This father deals with his anxiety by continually trying to know - and the anxiety is passed on to the sons. (Recall that one of Nimier's defences against anxiety was an attempt at omniscience; see Sec. 8.3.2.)

Or perhaps his father's approach was a deliberate pedagogic device, based on a wish to share the idea of the usefulness of books? For whatever reason, Peter ends up by resisting the authority of the book, and that of his father. Yet, despite his resistance to his father's methods, Peter seems, sometimes at least, at one with him, in his "need to know everything about a maths problem, everything about .. an idea in maths, for me to understand it..."(p.7). Does the son identify with the father in this respect?

In the only mention of his mother, she is presented as having an "awful habit": she adds up her shop receipts only when she gets home and, if she's overcharged, it's too late to do anything but go into an impotent rage. It is perhaps significant that this story about his mother followed immediately after his fantasy of summing the total cost of a meal, including coffee (27p). Do his imaginary stories of mastery allow him to identify in some way with his mother? In a way, he is at one with her in his tendency to fail to do the right calculation at the right time. And perhaps in his isolation from the knowledgable, mathematical men in the family?

But why does she do this; what do these small amounts of money mean for her? For him? There seems to be a strong moralism, and perhaps strong anxiety, around money in this family. We can compare this with Alan's lack of worry about money, which we can infer was shared by his parents (who left him £10 to top up the family supplies, when they went away for a week). It is also different from the fantasies of Donald and Harriet, about discounts on things which they desired but did not have the money to buy. In Peter's family, there seems to be an anxiety about losing what you already have, rather than anxiety about never having had things. This suggests a middle class position "lower" than that occupied by Alan's family. (NOTE 18a)

This interview allows me to explore a number of themes, including:
- a positioning as incompetent in maths, especially in the family discourses;
- pressure, relief and resistance, related to his positioning in the family and related to school maths;
- the involvement in fantasy in a somewhat different way from Donald and Harriet; and
- possible indications of identification and transference.

11.3 Summary and Conclusions from Case Studies

The seven case studies discussed in this chapter address all eight themes of the "qualitative", interview-based part of this thesis. They reinforce Themes (1) and (2), developed in Ch.10 - that context should be understood as integral to activity, as positioning in practice. The case studies develop Themes (3) and (5) by considering gender and class differences in cognition, and gender differences in affect, in a more particular way (see Ch.8), than could be done in Ch.10. And they address Themes (4), (7) and (8) about the specificity (to practices) of cognition, affect, and their relationship. For Theme (6), I give illustrations of other feelings expressed or exhibited, drawing on psychoanalytic insights, where appropriate.

Before summarising the findings, I should stress the limitations of the case study data. It is not so much that the number of cases is small, as emphasised in the cross-subject analyses in Ch.10 (NOTE 19). It is rather that the amount of research material for each case is limited - one questionnaire and one interview of 1/2 to 3/4 hour - though in many cases, it is supplemented by notes of other interaction (see the general reflexive acount in sec.9.3.3 and the reflexive account for each case in Sec.11.2). Nevertheless the aim has been to argue as convincingly as possible for the interpretations offered here, and to reflect critically on more traditional accounts of "mathematical" thinking amd "mathematics affect".

Concerning Theme (4), numerate cognition as specific to positioning, analysis of these case studies shows that the subject's thinking and performance on "mathematical" problems depends on the practice(s) in which s/he is positioned. Thus, Donald shows his awareness of the different "languages" underlying SM and the money markets practices. Jean's problems with percentages relate to "conceptual difficulties" within the school maths (SM) discourse, whereas she solves the problem of giving a tip on a restaurant meal without evincing any such difficulties. Alan produces a solution for the best buy shopping problem by drawing on "everyday knowledge" about the most economical size of jar, and thus declines to address the problem within a SM context. Fiona, purporting to call on everyday discourses, also "refuses the terms" of two problems - and hence is read as performing incorrectly. Peter calls up SM for most problems, but generally calculates in his head - rather than on paper as would be expected for SM - because of the way he has been positioned in SM practices (especially in doing homework with his father). Ellen draws on her familiarity with SM, or perhaps eating out practices, in order to be "critical" of a calculation where she has made a slip.

Similarly, for Theme (7), this analysis supports the idea that the emotions experienced, especially anxiety, are also specific to the practices called up. Thus the responses of

Fiona and Ellen to Qus. 3 and 4 respectively may well signify anxiety, but I question whether this anxiety which might at first seem "mathematical" is not instead (or at least additionally) related to another practice in which the subject is positioned. For Fiona, this was as a child who "wouldn't understand" in family discourses about her father's work which supposedly entailed financial risks threatening the whole family. For Ellen, the positioning seemed to be as someone "who doesn't usually pay" while eating out with someone in relationship to whom she is afraid of being "an expense". Harriet and Peter appear to lack confidence in maths; this seems to relate to their experiences of being watched, and thus regulated, by their fathers in doing maths homework. Alan <u>expresses</u> no feelings about maths in the interview or in the questionnaire, but I argue that he <u>exhibits</u> anxiety, or more precisely defences against anxiety, in several ways (see below). In fact, for many students - and for all seven cases, except perhaps Ellen, in their different ways, school maths and college maths are related to "negative" affect - dislike, anger, boredom, diffidence, and especially anxiety. For Donald, in addition, "bad feeling" is associated with some aspects of work practices, e.g. the competitiveness.

So far, I have argued that cognition and affect are each specific to the subject's positioning. In addition, Theme (8) points to the relationship between cognition and affect as specific to discursive practices, too. To begin with, more confused, less cogent performance may be observed when school (or college) maths is called up. This is not only because of misconceptions, memory failure etc. - though sometimes these may be crucial, as in the case of Jean - but it may also be related to the negative emotional charges that are in many cases specific to academic maths practices. Harriet, Fiona and Alan, in their refusal to attempt Qu.5B [9% of £66.56, exactly], and Peter throughout illustrate this. In contrast, for Donald, the bad feelings associated with work do not <u>seem</u> to have interfered generally with the numerate aspects of his performance there (despite his slightly perplexing slip in reading the graph in Qu.3 - see sec.10.3). Ellen's case in particular shows that affect (here, anxiety) associated with a relationship associated with everyday practices of eating out can interfere with cognition - including numerate cognition that may look like "mathematics". Overall, I argue that the relationship between anxiety and performance, rather than being simply general across subjects, can only be fully grasped through analyses of particular cases, and with reference to positioning in practices, as is done here. (See also the discussion of psychoanalytic insights below.)

Themes (3) and (5) point to gender, class and other social differences in cognition and affect. The analysis here shows the importance of such social differences, as they relate to the subject's positioning within the practices called up. For example, the positioning of Ellen, a young middle class woman, as someone "who doesn't usually pay" has effects both on her thinking around calculating a tip, and on her feelings about it. Fiona, the other middle class woman, is sometimes positioned that way, but also can consider the problem from a position within "going dutch" and as a former restaurant worker. Peter, as a the <u>youngest son</u>, was positioned by his family discourses, as subject to pressure to take maths (and science) GCE exams, and to know about these subjects in a certain way. As a child, he was subject to this age-related regulation - as were Harriet and Fiona in similar ways which are relevant to the way they have been positioned: as knowing or not about school maths (Peter), as capable (or not) of knowing more generally (Harriet), or as able to "understand" (or not) her father's work (Fiona), respectively.

These interviews also illustrate a number of ways in which social class cultures position subjects. For example, though there are similarities between the way that Harriet's and Peter's fathers regulate their homework in maths, there are also crucial differences: Harriet's father is anxious about knowing, and about his own - and her - ability to know; Peter's father seems (from his son's account) to be less anxious about how you get to know and wants his son to follow his example, e.g. by consulting books on the subject. More generally, these interviews show all the subjects to be very specifically positioned in terms of relative affluence or relative poverty in a range of practices - from Jean's worry and pain about never having enough money, to Alan's lack of concern about best buys in shopping. Also striking are Harriet's and Donald's fantasies, using numeracy, about reductions in prices (see below).

At the same time, the comparison between Alan's and Fiona's views about the comparative importance of time and money in certain contexts shows the scope for variation, even within the middle classes. (NOTE 18) In general, what I have shown in this chapter and the last, is the importance of "structural" approaches, but also their limitations. The case studies, especially, show the need to take accout of the <u>particularity</u> of positioning, by referring to positions within specific discourses.

Part of the way affect has effects is through making the discourse of mathematics - or at least some parts of it - <u>familiar</u>, rather than "alien". (NOTE 20) The idea of "familiarity" with a discourse is a crucial straddling concept between cognitive and affective. As discussed in the case of Donald, it embraces a number of aspects. First, it requires "knowing the language" (Sec. 7.5 and Donald's response to the "graph" / "chart"). It involves the memory, and may be developed by repeated exercise (see Peter's statement about "coasting" once he has "figured out the simplicity" of a sum). But you must also have a "feeling" for it, which may sometimes be "intuitive". Part of the feeling is having an idea of possible "solution shapes" (cf. Lave). Familiarity may be related to confidence, but it may also be linked with bad, or mixed, feelings. It may be developed within relationships with positive affective charge, but again this will not necessarily be so. Finally, familiarity with something involves seeing it as meaningful or appropriate for yourself, as not alien (Murphy, 1989), as something you "can do" (HMI, 1989).

Other examples of the use of the "solution shape" are provided by various examples of subjects' "critical" reflection on originally erroneous or implausible answers to Qu.5; see Sec. 10.4. It is also illustrated by Ellen, who rejects her calculated tip for Qu.4, because she "just saw ... that it was far too small".

My characterisation of "familiarity" thus has some aspects which can be seen as largely affective, some as largely cognitive, as well as some aspects which clearly straddle both - e.g. "having a feeling for" the activity. This represents a development from the basically cognitive familiarity used in explanation by Scribner, and Lave. In my approach familiarity plays a central role in attempts to consider the cognitive and the affective as part of one whole.

Further, several subjects appear to distinguish between, or "pigeon-hole", different "aspects" or "types" of mathematics, in terms of "can do", familiarity, etc. - as do many other interviewees not discussed in detail. Besides having substantial cognitive consequences, this process is also profoundly affective, and particular to the person concerned. For example, Donald appears to distinguish between "figures" on the one hand, and "formulas and rules" on the other. This relates to a distinction between work practice (maths) and school / college maths; these occur in different contexts and are marked by a range of different feelings. Jean articulates her distinction between two exam courses - CSE Maths and CSE Arithmetic on the basis of "usefulness", and whether it should be optional or compulsory; she relates this to a similar division in topics in the 1st year maths course. Peter uses the dimensions numerical / not, useful / not, and pressure / relief, in a somewhat fluid way to distinguish mathematics and physics, from the sorts of subjects he took at A-level and now college.

These divisions recall Bernstein's (1971) concept of "classification", used to describe the strength of boundaries between curricular subject contents in educational knowledge. These subject contents are _socially_ recognised, and he discusses their _effect_ on the "identity" of teacher and student. This can be contrasted with the boundaries involved in the sort of "distinguishing" I am pointing to, which appear to be _particular_ to the subject (at least to some extent) and to be _part of_ (or to flow from) his/her subjectivity. Hence, my use of the term classification here is based, not on structural differences between codes, as in Bernstein, but rather on differences related to the learner's subjectivity. The boundaries between academic subjects thus are both profoundly affective and cognitive. (NOTE 21)

Insights from psychoanalysis have been fundamental to the account of affect produced here; this is because so much affect is suppressed (because the ideas linked to the affect are repressed into the unconscious). First, in considering theme (5), it has been possible to use the distinction between _expressing_ anxiety and _exhibiting_ anxiety - in order to go some way towards taking on board the idea that anxiety may be unconscious, because of defences against it. Thus I have been able to sensitise myself to cases where anxiety has not been expressed, but where there are indications of defensiveness - and hence to move beyond the limitations of dependence on subjects' reports of what they feel.

Second, it is important to describe all types of affect, expressed or exhibited, as indicated in theme (6), since anxiety may apparently be transformed by the operation of defences such as denial and "reversal into its opposite" (Laplanche and Pontalis, 1973, pp.399-400.) Significantly, it has been possible to describe what may be defences against anxiety in all seven cases here: Ellen's repeated expressions of confidence, Jean's "insouciance", Fiona's jokiness, Harriet's pleasure in formulae, Alan's protestations of neutral feelings about maths, Donald's forgetting of school, and Peter's attempts at denial (of his alleged failings in maths) through fantasy.

Third, the object or focus of anxiety, anger, etc. may also be transformed by the operation of unconscious processes. Thus I have illustrated the use of displacement / metonymy and condensation / metaphor in the interpretation of chains of signifiers and key signifiers, particularly in Ellen's case. Fiona and Peter also express anger about their regulation by their fathers in various discourses, which anger I would argue is likely to be displaced onto mathematics or maths teachers.

Psychoanalytic insights allow us to appreciate the emotional charges which motivate much of social life in sometimes surprising ways. For example, I have argued that the concept of "splitting" (in the Kleinian sense of a defence) may help to explain a division of labour in Fiona's family when she was growing up: her father practised the calculating, the rationality, while the rest of the family, including Fiona and her mother, "held" the emotions - anxiety and anger, in Fiona's case. Thus this particular psychic defence may underpin, or infuse, the dimensions of difference - here gender and age, which form the basis for certain arrangements which may be seen as sexist or "adultist". (NOTE 22)

We have also seen the possible effect of subjects' "investments" of affect on the answers given - especially as "motivation" for "slips". For example, Ellen, after choosing the least expensive dish on the menu, made a slip in calculating the tip that made her less of an "expense". Jean made a slip in interpreting Qu. 8 [cost of sports kit] that led to a lower cost, and presumably lessened her evident worries about money.

Fantasies provide a site where the subject can be in control, and several subjects produce them here. Both Donald and Harriet had fantasies in which they used numeracy to make up prices, and to calculate discounts in shops. If these were about goods which the young child desired, but the family couldn't afford, then they may have had effects - not only in providing wish-fulfilment (in the form of fantasies of having something desired - see ch.8) - but also possibly in motivating Donald to "work with money", and in supporting Harriet's creation of shortcuts to mental calculation, e.g. of 15% as (10% + 1/2 of 10%). Some of Peter's fantasies, however, seem less successful.

Legault (sec 8.3.2) directs our attention to the description given of family relationships in interviews such as those analysed here. There are striking differences in the prominence given to family - and these seem not to correlate with age or gender. Ellen, Jean and Dennis make no mention, and Alan mentions his "parents" very little. On the other hand, Fiona, Harriet and Peter mention their fathers a great deal. The two women mention their mothers a bit, and their siblings by implication - whereas Peter mentions both his mother and his oldest brother prominently. For these latter three, in very different ways, the father represented knowing mathematics, doing mathematical work, and/or the need to know mathematics.

These three subjects show the most resistance to doing maths problems in the interview; this resistance can perhaps be understood as an effect of being positioned in these different ways in learning maths. (Fiona and Peter, plus Alan and perhaps Jean, seemed most resistant to doing maths once they were at college.)

A psychoanalytical approach alerts us to the possibilities of <u>transference</u> in research settings. Hunt (1989) uses the term to describe the subconscious reactions of either subject or researcher to the other. In this set of interviews, transference reactions towards me, as interviewer, as maths teacher, seem to be a possible dynamic in the case of Fiona, Harriet and Peter. This is not surprising, since all three subjects had fathers who in one way or another were associated with learning mathematics. And I was an older man associated with the learning of mathematics. Being aware of possible transference alerts us to powerful forces shaping what may otherwise be less comprehensible behaviour on the part of subjects, in particular in these cases, to their resistance.

Hunt points out that transference can work in the other direction as well. For example, in constructing the usual "reflexive" account for Ellen's interview, I concluded that, as a defence against my own anxieties, I may have been "motivated" to give her a <u>more difficult</u> problem for the second half of Qu.4 - a tip of 15% rather than 10% - than I did to the other subjects.

Thus the concept of transference allows us as researchers to investigate more deeply the "relational dynamics" in the research setting, as recommended by Walkerdine (1988) in her discussion of Cole and Traupmann's account (1979) of the dificulties in research involving "Archie"; see also Sec. 8.5. It will be recalled that in two incidents Archie was given a task that was "easier" than were other children. For example, in a formal testing session, the tester decided to let Archie answer the question under less difficult conditions than were set down. Cole and Traupmann do not raise the issue as to whether her decision might have been made for reasons of which the she was not fully conscious - to do with defenses against her own anxiety or emotional distress. However, the examination of my own decision to deviate from procedure with Ellen shows how to investigate the relational dynamics of the interview in a way that takes account of the importance of unconscious defences against anxiety.

This analysis drawing on psychoanalytical insights shows the limitations of the usual clinical interviews used in maths education, and of traditional fieldwork methodology, but also how to extend them to provide a fuller discussion of affective issues - through the use of concepts such as the unconscious, defecnces, and transference.

The interview also gave space to subjects, especially Donald and Harriet, to describe the beginnings of a "second chance" with mathematics. In Harriet's case, the interview itself can be seen to have played a powerful "consciousness-raising" role.

It is possible to ask whether _either_ student might be a candidate for taking up "the mastery of reason. Donald certainly expresses an interest in doing a Maths degree, perhaps at the Open University. However, we can ask whether he will be a prisoner of his early fantasies, and his (possible) sublimation of them in his money-market dealings - where his facility with reading figures and calculation are, as he recogises, "no help with mathematics at all". He may also be limited by his own expressed anxiety about formulae, which is perhaps reinforced by his "classification" of numerical thinking as so different from mathematics.

Harriet appears to call up practices other than academic maths for most episodes, and her orientation to number and quantity seems rather "practical", unlike the "mastery of reason". But she likes "messing around with formulae", and she refers to the pleasure of remembering about binary numbers. (In her interview, there is less talk of "classification" than there was for many others.) But for her to enter fully into mathematical discourse, she would have to find a way to suppress the painful associations of her isolation in her family, related to her own (and her father's) confusion and ambivalence about the burdens of knowing, and also the echoes of disappointment (and perhaps competition) from her school experiences with maths.

Peter, because of his apparent ambivalence over the sort of mastery attained by his father and because of his painful associations with mathematics, seems to desire a sort of "coasting", which is rather more like "relief" than mastery. He seems less likely than Harriet or Donald to experience "pleasure" in doing maths.

This chapter has emphasised the analysis of the seven case studies, folowing on from the cross-subject analyses in Ch.10. The use of case studies has allowed me to develop my alternative views of numerate cognition, and especially of affect, and to show their value in considering the themes set down for the qualitative part of the research in Ch.9. In the final chapter, I bring together the main conclusions of the thesis.

CHAPTER 12 : CONCLUSIONS AND CONTRIBUTIONS

So that is what we can use the multiplication table for ....

(Chilean metallurgy worker, at a lunch-time class on reading blueprints, during the Allende period, quoted in Zaslavsky, 1975)

In this final chapter, an overview is given of the findings of the research and the theoretical conclusions. These draw on more detailed summaries of earlier chapters, and only the most important points are included here. Sec. 12.1 discusses contributions to theoretical discussions, and reconsiders some previous findings in the light of ideas developed here. Sec. 12.2 discusses applications of these ideas to several areas of pedagogy and practice, and Sec. 12.3 discusses contributions to methodology. In Sec. 12.4, possible areas for further research are briefly discussed.

12.1 Conclusions and Contributions to Theory

12.1.1 Developing ideas

The broad aim of the thesis has been to understand adult numeracy, and how it is developed. In Ch.1, several aspects of this aim were identified: developing the idea of numeracy, its grounding in practical contexts, the role of affect in numeracy, and the relationship between affect and cognition. I discuss the theoretical contributions of the thesis under these headings.

Numeracy is here understood, not as low-level applied mathematics, but as cognition, problem-solving in a variety of discursive practices, deploying ideas and "skills" which can be seen as numerical, quantitative, spatial, and which are meaningful within those specific practices. This contrasts with the view current in much maths education and psychological research that cognition is done basically in the mind of an isolated individual. Consistent with this latter view are two slightly different ideas of numeracy. In the traditional view (N0), numeracy is considered to consist of abstract basic skills, assumed to be straightforwardly applicable (or "transferable") to a wide range of contexts. On the other hand, in the "utilitarian" views (N1) promoted e.g. by Cockcroft (1982), the definition and measurement of the set of "functional numeracy" skills is seen as related to one or more practical context(s); there is more attention given to describing the context and "transfer" is seen as much less straightforward. Nevertheless, these two conceptions of numeracy share certain crucial features. The mathematical content of a problem (or of thinking about a problem) and the context are seen as able to be separated, and hence two tasks which can be seen as isomorphic mathematically, though embedded in different contexts, will be seen as "the same" (see Sec. 2.2 and Ch.7).

In the course of the intellectual journey represented by this research, the quantitative strand was done using a N1 conception of numeracy. I divided my performance items into "school maths" (SM) and "numeracy" or "practical maths" (PM) types on the basis of whether they were abstract, or located in some "practical" (non-school) context, respectively, using the wording of the problem. The results showed somewhat higher levels of numeracy (PM performance) among my sample of students (many 21+) than for members of the public surveyed in connection with research done for the Cockcroft Report (ACACE, 1982), as expected - except for two questions. In these, differences in question format or in the social relations of the research (self-completion vs. interviewer-administered questionnaires) may have been crucial (see Sec.5.2). This was one of the findings which raised questions about the N1 conception of numeracy, specifically about whether a difference in wording was a valid basis for making the distinction between school maths and numeracy. (NOTE 1)

Both these questions, and my coming to see numerate (or any other) cognition as specific to a specific context / practice (see Ch.7) - rather than a basically general "set of skills" (N0) or a "lightly-contexted" one (N1), led to a different view of numeracy (N2) - as the numerate aspects of thinking in everyday practices. Since such practices are based on shared languages, goals and values, characteristic social relations, and available institutional and material resources (see Ch.7), the practices and the related contexts must be understood as profoundly social, and the thinking produced as not just the accomplishment of an isolated individual. The pervasiveness of goals and values means that critical evaluation is a feature of every stage, and that methods specifically "tailored to the occasion", such as estimation or approximation, may be selected - or invented. (For more detailed discussion of the process of numerate problem solving, see Sec. 10.6.) (NOTES 2, 3)

In the ideas being developed here, the context is considered to be an integral part in defining the task, and in allowing performance to be read: instead of cognition and context, we have cognition in practice (Walkerdine, 1988; Lave, 1988), "situated cognition" (e.g. Brown et al., 1989) and "situated learning" (Lave and Wenger, 1991). Thus, numeracy in various everyday practices is "discontinuous" with (Lave), and is to be distinguished from, skill in school maths. And an assumption that the skills can be easily "transferred" from one context / practice to another must be considered sceptically (see Sec.12.2).

The position being developed here thus attempts to move beyond those of the utilitarians, ethnomathematics researchers and the Brazilian School of Carraher, Carraher and Schliemann (CCS) (Ch.7). In some of the latter's work, despite the inclusion of ethnographic description of numerate thinking in everyday settings, the experimental phase allows variation only in "situation" (or background to the problem-solving), thereby limiting the study of contextual features (e.g. Carraher et al., 1987). The analysis here also allows us to reconsider the distinction made by CCS (1987) between the use of oral and written procedures when solving "mathematical" problems (see Sec. 7.3). This distinction refers to the characteristics of a class of procedures or methods of calculation; it is useful, since the basis of the distinction is overt - but it can also be deceptive: for example, Peter uses school methods but invariably calculates in his head ("orally") for subjective reasons (see his case study). Though CCS make much of the distinction, they ultimately make it clear that the <u>basis</u> of the distinction is the <u>context</u> where the methods were learned - in school or "in the street". However, they are not specific about <u>why</u> the context makes such a difference (1987), though they allow the context might relate to the "relationship" between researcher and researched. In the analysis here, I show the basis of the "context" in discursive practice(s), including relations of power and desire.

The work of Michael Cole, Sylvia Scribner and other US researchers drawing on activity theory has made valuable contributions to seeing thinking and actions in context. However, many studies are limited in their tendency to see subjects as positioned generally in one basic activity (usually a work practice), and in their underemphasis of affect. Jean Lave's work encompasses the idea of the "proportional articulation of structuring resources" (positioning in multiple practices), but for her, too, emotions are experienced in a rather cognitive way. These researchers also appear to lack a systematic way to describe the structure of activities or practices, though Saxe has attempted to analyse the goal structure of simple activities (see Ch.7).

The work of Valerie Walkerdine makes good these gaps. She draws on theories of signification to analyse the elements and structures of discursive practices, in particular signifier / signified relations and devices such as metaphor and metonymy. This allows the analysis of meanings, both at a general level and for particular subjects. It thus provides the basis for understanding how subjectivity is formed: this includes the ways that subjects examine and think about specific problems to be solved, and indeed the emotions they feel.

In this work, I see the context of cognition in practice as "constituted" by the discursive practice(s) in which the subject is positioned. It is necessary to specify the practice(s) within which the subject is addressing the problem - that is, the subject's "positioning" in discourse. Here I have attempted to produce a synthesis of previous answers to this problem, that would avoid tendencies to overemphasise either the determination of human action - as in some of Foucault's work, or alternatively its freely chosen character. My approach involves describing the positioning of a subject confronting a problem as a "resultant" of the practice(s) in which all subjects in that situation are positioned, and the practice(s) which the particular subject calls up. My analysis of the interviews in this study shows that it is often (though not always) possible to describe a particular subject's positioning in a particular situation - and to understand their thinking and emotions in this context.

Further, I also see affect as an inseparable aspect of numeracy. I resolved at the beginning to focus on anxiety. Traditional psychological approaches conceive of anxiety as a general "trait" of the individual, observable and quantifiable, and, in many cases, as measurable indirectly by self-report. (NOTE 5) In these approaches, the context is given by brief descriptions of the situations of interest in the questionnaire items, e.g. for "maths anxiety". In my analysis, I discussed generally the difficulties of classifying items into "maths test / course anxiety" (TA) and "numerical anxiety" (NA) dimensions (Rounds and Hendel, 1980), parallel to SM and PM performance respectively - and also found several anomalies when I attempted to confirm this classification the items using factor analysis (NOTE 4). On reflection, I also questioned whether the descriptions of the context in these items are sufficient to give a valid indication of what would be the subject's emotions in the actual situation (see Interlude).

The meanings of the self-report maths test anxiety scores are uncertain in another way, since they could at best be a measure only of what would be expressed anxiety in the actual situation. Once it is accepted that anxiety may be unconscious, it becomes necessary to look instead for indicators of defences against anxiety: anxiety may then be exhibited as confidence, or as a "slip", etc., or as nothing at all.

In this research, it has been argued that anxiety - and affect more generally - are specific to specific practices. And if a subject is multiply positioned, his/her anxiety may relate to more than one context or practice. Thus Ellen, when asked to calculate a 15% tip, exhibited anxiety which I judged to relate (at least partly) to being "an expense" within a relationship which formed the basis of her eating out activity, rather than being "maths anxiety". (Her anxiety may also have related to being interviewed.) In addition, I have followed the Freudian position that affect can be thought of as a "charge" attached to particular ideas. However, rather than considering the movement of this charge to take place along chains of associations, I have adopted the (Lacanian) view that affect can be displaced along chains of signification, where the links between signifiers are meaningful as well as based on contiguity. Thus, for example, Fiona produced a chain of signifiers particular to her own "history of desire", which linked the signifiers "calculating" and "mathematical" to her father's work (see Ch.11).

The study of anxiety cannot be separated from the study of affect more broadly, for at least two reasons: (i) anxiety and other emotions may be difficult to separate if they occur together in a string of emotions; see e.g. Fiona's story about the anxieties, uncertainties and disappointments in growing up at home; and (ii) because of defences, etc., anxiety may sometimes be presented as another emotion, say anger or confidence. Thus, the interviews analysed examples of a range of feelings associated with school maths: confidence, diffidence, pleasure, dislike, anger, and boredom (see the case studies in Ch.11, and the additional illustrations in APPENDICES U1 and U2). Sometimes, a subject splits mathematics into different "types", with one part the focus of negative feeling and one part experienced more positively (see the discussion of "classification" in Sec. 11.3.)

However, with explanations emphasising the affective, including those using psychoanalytic insights, there is difficulty in giving sufficient weight in explanation to the social. One of the contributions of post-structuralism (see Chs. 7 and 8) has been to show how to understand particular motivations in terms of social difference and deprivation, as well as desire in early family dynamics. Thus, if we consider the basis of Donald's pleasure in controlling large sums at work "as if it was your own money", we might start from different points: with a purely psychoanalytic approach, from desire for his mother; with a materialist approach, from the need to overcome early deprivation of material goods (the objects of his fantasies). In aiming, however, to use a psychoanalytic approach informed by post-structuralism, it is possible to acknowledge the likely complexity of the bases of his feelings, and to study how these apparently different bases may be linked through chains of signification.

12.1.2. Reconsidering earlier findings

One of the objectives of the first (quantitative) part of the research was to consider critically the findings produced in many psychology of mathematics education studies, including:

- performance differences in school maths in favour of males;
- more maths anxiety among females than among males; and
- maths anxiety as (simply) debilitating of performance.

First, the idea that "men are better than women at maths" received confirmation from the analysis of the uncontrolled questionnaire results - though once controls were provided for qualification in maths, age, social class, etc. in the statistical modelling, the differences were generally reduced. Sometimes, they were no longer statistically significant, and sometimes they were specific to subgroups in the data, e.g. older (21+ or 25+) females with low (or no) qualifications in maths (see Sec. 6.3 for more detail). That I produced only a partial "replication" of the usual findings is notable; this may perhaps be due to the rather special nature of the study population - but few of the studies reviewed have used the range of controls, etc. deployed here.

In the cross-subject analyses of the interview (e.g. problems 2 and 3), gender differences were at first apparent, but these disappeared for high-qualified (O- and A-level Maths) men and women; this left a lower-performing group of low-qualified women similar to that noted on the questionnaire - though the total number of interviews was small (n=25). On further examination, these differences appeared to hold only for those students who had called up school maths for Qu.2, but with such small numbers, this can only be suggestive. A related and possibly important tendency, evident for Qu.4 [tipping], was for women to call up school maths (rather than eating out) more often than men. Again, with small numbers, this tendency is only suggestive, but its relevance for explaining gender differences in performance on a wider range of practical problems should be further investigated.

In seeking to explain performance, gender differences (or indeed any set of "structural" differences) cannot be expected to tell the whole story. Thus, we return to the idea of cognition as specific to positioning; for example, Fiona's response to the tipping problem differs from that of Ellen, since the former can address it from the positions of waitress and "going dutch", as well as "non-paying customer".

Next, the finding that women "are" more anxious about mathematics than men received confirmation from the analysis of the questionnaire results (see Sec. 6.2). My first response that, rather than being more anxious, women are simply more likely to express anxiety, received some confirmation from cross-subject analysis of the interviews (see Sec. 10.5). However, this risks a new kind of gender essentialism. Against this, the idea that anxiety is specific to (positionings within) practices means that anxiety is produced within specific practices - the same practices within which thinking, in particular numerate thinking, is produced.

Now, the evidence from cross-subject analyses of the interviews in Ch.10 is suggestive (only) that women more often called up school maths (rather than other practices) to address the problems presented (see above) - and also that women expressed anxiety slightly more often than men when they had called up academic maths (Sec.10.5). Yet even if my sample of women did express anxiety more often than men in episodes in the interview where they had called up school maths, this does not necessarily guarantee that anxiety was more likely to have been produced for these women in school maths - though the arguments of Walkerdine, Gottheil and Horner (see Sec. 8.4) make this conclusion plausible. (NOTE 6)

There are further issues limiting the conclusion that gender differences in expressing anxiety in what appears to be an academic maths context are to do with maths anxiety. First (and parallel to the argument above for performance), gender differences (or indeed any set of "structural" differences) cannot provide a full explanation of differences in anxiety. Indeed, gender cannot merely be seen as a structural attribute. Rather, gender itself, and more generally subjectivity, are produced within discourses. Again Ellen's positioning in the activity of eating out provides a good example (though the interview material is limited): it is not on her gender alone that we must focus, so as to understand her anxieties, but rather on the meanings generated by the discursive practices providing the basis for her positioning.

Second, if a particular subject is multiply positioned, the anxiety may relate, not to academic maths, but to another practice; as indicated above, Ellen's anxiety, which at first seems "mathematical", because it arises in connection with an arithmetic calculation, arguably relates to her positioning in the activity of eating out. It also seems to get attached to the numerate aspects of that activity - such as calculating a 15% tip, and indeed ordering (and costing) a full meal - through displacement and condensation (see Ch.11).

The relationship between cognition and affect was considered in a number of ways in this study. First, possible relations between quantitative indicators for maths anxiety and performance were explored using statistical modelling. Using more extensive controls than in most previous research (see above), and more flexible modelling procedures (allowing for a non-linear relationship) (NOTE 6a), an inverted U relationship was found between the score on the school maths performance subscale and that for the "maths course / test anxiety" subscale of MARS (and a similar relationship between the practical maths score and that for numerical anxiety). These inverted U relationships suggested that the relationship between school maths (or practical maths) performance and the corresponding dimension of maths anxiety might be facilitating for moderate anxiety levels, and debilitating for higher and lower levels. These findings raise questions about the adequacy of the design of many previous studies for replicating (or otherwise) the inverted U relationship. If confirmed, they would also raise questions about the theorisation of the relationship between anxiety and performance in mathematics education and psychology over the last 20 years.

However, a number of other questions were posed about this relationship - about the validity of indicators especially those for maths anxiety and about the direction of causality (see the Interlude) - which seemed to suggest that the meaning of the inverted U relationship was limited and somewhat uncertain. (NOTES 7, 7a) This led me to attempt to consider the relationship between cognition / performance and affect / anxiety, using more detailed interview material.

In the same way that I have argued that both cognition and affect are specific to positioning, the results here support the idea that their relationship will be similarly specific. For example, Jean for Qu.2 [abstract 10%] is positioned in school maths and as a research interviewee; in both of these positionings, she feels anxiety, and further she is subject to misconceptions about percentages in SM; these reinforce each other to undermine her thinking about the problem. For Qu 5B [9% wage rise], Harriet calls up school maths, which for her is charged with diffidence (see the discussion of her "life history" in Ch.11), and she refuses to attempt an answer in front of me in the interview. Ellen for Qu.4 [tipping] calls up predominantly eating out, in which she is anxious and also unfamiliar with procedures for calculating a (15%) tip; this seems to lead her to make a "slip" in her calculation. For Qu.3 [graph of changing gold price], Fiona calls up family discourses charged with disappointment, anger and anxiety, which along with the anxious charge for school maths, interferes with her attention to the numerate aspects of the problem.

The research also illustrates a number of ways in which affect can support, rather than interfere with, cognition. For example, both Donald and Harriet have gained pleasure from playing with figures, which I argue may relate to earlier fantasies involving (calculations of) price reductions of goods in shops. Keith (see APPENDIX U2) claims to have derived pleasure from both school maths and college maths, and he illustrates this with a creative response to Qu.6 [best buy]. However, positive affect does not necessarily support cognition as Harriet's case shows (see also Walkerdine's (1988) example of children enjoying the shopping game at school). Similarly, bad feelings do not appear necessarily to interfere with cognition; e.g. Donald's bad feeling towards competition-inducing wall charts.

I have characterised the idea of familiarity with a practice (see especially Donald's case study), and have argued that it should enhance a subject's thinking and learning within the practice. Thus, familiarity can be seen as a bridging concept between cognition and affect (see Sec. 11.3). (NOTE 8)

Now, many of the conclusions in the discussion above on the relationship between cognitive and affective, depend on describing it in terms of affect "supporting" cognition, or "interfering with" it. This would be in line with modernist discourses which produce subjectivity, i.e. the identity of a rational unique self, only by marking the latter's difference from the affective as the "other" of the cognitive. However, I have attempted to inform the analysis of this issue with insights from psychoanalysis that see the affective in terms of charges attached to (or infusing) ideas, and as related thus to the cognitive. In this psychoanalytically informed view, the affective is not entirely "other" to cognition.

Further, in psychoanalysis, as we have seen (Sec.11.3), affect can be displaced onto ideas different from those to which it was originally attached. This means that, though affect is not entirely "other" to cognition, neither is it completely "at one with", or inseparable from, cognition. These ideas have been used in the analysis of the case studies, notably in Ellen's and Fiona's (see above and Sec.11.3).

12.2 Contributions to Pedagogy and Practice

The "transfer" of learning can be considered to refer in general to the use of ideas and knowledge from one context in another. It often is used particularly for the "application" of knowledge from academic contexts to work or everyday activities. This is clearly a central problem of training, and also for many conceptions of education. The traditional view holds that if an idea is well understood in its generality, its abstraction, then it can be applied to a whole range of practical contexts; clearly, mathematical ideas should be prime candidates for such transfer. However, in practice, subjects often seem to fail to accomplish transfer.

Some researchers discussed here would argue that part of the problem stems from the specific quality of both "outside" discourses and school maths - as against the view that school maths is more general, more straightforwardly powerful, and hence in some sense privileged. The privileging of the abstract, of school maths, leads to the traditional position's being normative (Lave, 1988): "can be applied" easily becomes "should". Several subjects illustrate how this can hinder understanding of cognition; for example, for Qu.6 [best buy], Alan calls up shopping practices - in which for him great value is not placed on operations aimed at saving a few pence, or indeed on saving money at all - and school maths is not called up. In such cases, a researcher may conclude that a "mathematical" signifier is not recognised as such, whereas it may be recognised, but its mathematical meaning be undermined by competing values related to other discourses (see Sec. 7.1 and also Dowling, 1991).

There have been responses to claims of privileged generality for school discourses like mathematics from researchers such as Scribner and Saxe (see Ch.7). Saxe, for example, recommends that transfer be conceived as "an extended process of repeated appropriation and specialization" -

rather than as an "immediate generalization" of prior knowledge to a new context (1991b, p.235). However, the qualifications stipulated by Saxe (see sec. 7.4.4) do not constitute a challenge to the cognitivist assumptions (NOTE 9) within which learning transfer is understood. While there is a weakening of cognitivist claims (towards emphasising more specific processes), still situations are perceived in terms of their cognitive elements: specialised knowledge-forms, motivations of individuals addressing problems, and the appropriation (through cognitive schemas) of the knowledge involved in the activity.

There are several differences between Saxe (and other "activity researchers") and the framework used here. First, the arguments here show that transfer would involve not only ideas, strategies, etc., but also values and feelings, carried by chains of signification. For example, it was argued that Fiona's errors on Qu. 3 may have related to the anxiety and anger associated with her positioning in family discourses as "not able to understand" her father's work in stockbroking. Further, the "contexting questions" used in the interviews (see Sec.9.2) have revealed a wealth of associations between the sorts of "mathematical" problems presented and the subject's memories and accounts of experiences which provide a context for speaking of the meanings that elements of these problems have. Illustrations of this wealth come e.g. from Ellen's and Fiona's cases (see Ch.11).

Second, the way the cognitive and the affective are linked through an emphasis on language and meaning also makes transfer depend on relations of signification in the two practices. Thus, for anything like transfer to occur, a process of "translation" / "transformation" across discourses would have to be accomplished through careful attention to the relating of signifiers and signifieds in particular chains of meaning (see Sec.7.5). Walkerdine also points to the possibility that differing forms of regulation, related to different positionings, in the two practices (e.g. a "game" vs. "school") may further limit possibilities of transfer (Walkerdine, 1988, pp.114ff.). The ability of a signifier to form different signs, to take different meanings, within different practices, constitutes at once a severe <u>limitation</u> on the possibilities of transfer, yet also the <u>basis</u> for any possibilities of transfer / transformation. (NOTE 10)

Thus we can see illustrations of the differences in goals and values, social relations and regulation - and especially language / signification and emotional associations - between different discursive practices which make transfer - in the sense of the application of concepts or "skills" from school maths to everyday practices - highly problematical. (For further examples, see Walkerdine, 1988). This means that transfer, because both of the vagaries of signification and also of emotional charges, will be difficult to predict or control. And it may not even be "positive", even with what seems the "right" pedagogic or social support.

This discussion of transfer in the sense of (attempted) <u>application</u> of school maths to non-school practices is meant to clarify the problems with the traditional view, and to point towards more scepticism in conceiving the problem. I also want here to discuss transfer in the "opposite direction" - namely, <u>harnessing</u> ideas or skills from non-school practices to use in school contexts.

Such "harnessing" is important in education at all levels, and examples exist of contexts set up in schools in an attempt to harness knowledge from pupils' non-school activities (NOTE 11). Harnessing is especially important in societies where recurrent education is common, or in institutions where "mature students" return to study after periods of work or child-care. However, the limits discussed above to the possibilities of transfer apply in both directions. (NOTE 11a)

Two proposals based on ideas from this study can be introduced here. First, Evans (1989b) suggests the creation of a new context for teaching social research methods and statistics, called community research. This context would be positioned between, and aim to draw on, both the course members' daily activities, as students and as members of various communities, and a course in social policy research methods and statistics. The aim is to encourage students to bring problems from their daily activities, to be addressed in the course. (NOTE 12)

The viability of this created learning context will depend on: (i) the ability to articulate shared goals from the outside and the academic practices, and to manage the constraints, e.g. as to time, in the two;
(ii) the ability to translate / transform between the two;
(iii) the use of methods from research methods to enhance the everyday methods available (or not) in the everyday practices; and
(iv) producing outcomes (e.g. project reports) that will be considered valid / valuable in the two discourses.
But there may be problems, such as:
- difficulties of seeing "relevance" of the course;
- difficulties of translation, e.g. "random" (probability) sampling understood simply as "haphazard";
- limited generalisability from the experience of doing one project in a particular area.

With these issues in mind, this created context, community research, might be expected to be shared to a reasonable extent, for certain groups of students - and their relationship to the academic discourses of social research methods and statistics might be seen as one of "barefoot statisticians" (Evans, 1989b).

The second proposal, for younger and/or more differentiated groups of students, Evans (1990, 1991b) is to seek to build up a relatively generally shared discourse around activities, in which the learners as "citizens", present and future, are highly likely to participate:
- purchase and/or growing, and consumption of food, and other necessities;
- involvement with, raising of children;

- paying for (perhaps building) and maintaining a dwelling and surroundings; and
- engagement with discussions and debates about personal, family and public well-being and about describing, evaluating, deciding on future directions.

A thoughtful engagement with these activities might be called critical citizenship. The "skills" necessary for its practice are likely to include:
- methods for the production of information / data at a small-scale level in the community (e.g. Cooper, 1986; Mellin-Olsen, 1987; Gerdes, 1985);
- the ferreting out of information produced, but not published / public (see e.g. Irvine et al., 1979, ch.10 for some hints); and
- the interpretation of information (e.g. Frankenstein, 1989, Ch.17; Marsh, 1988).

These might provide the basis for a course offered as, say, "statistics" or "mathematics across the curriculum" - or as "civics", or "responsible citizenship". More work on this is needed (cf. Thorstad, 1992).

These two proposals flow from my working through the issues of this thesis, and aiming to implement this thinking in my work as a teacher. I am cautiously optimistic as to their value, given the need for revising our intervention strategies - while retaining some scepticism about the easily drawn assumption that such linking will necessarily have positive results. In any case, these contexts provide a challenge for researchers interested in the transfer of learning.

12.3 Contributions to Methodology

This study represents an attempt to use the strengths of both quantitative and qualitative approaches. The quantitative approach used questionnaires, analysed with statistical modelling. The qualitative used semi-structured interviews analysed with a combination of a "cross-subject" approach based on Miles and Huberman (1984) and a "within-subject" case study approach. Because they were based in an institution of higher education with an unusually high percentage of mature students - most of whom had previously done full-time work and/or child-care, the samples studied were more representative of the population at large than are most college or university-based samples.

The quantitative strand aimed to produce a general overview both of levels of performance, etc. and of differences in performance and anxiety related to gender, social class, etc. The statistical modelling allowed hypothesised differences, e.g. in performance between men and women, to be examined while controls were operated simultaneously for a range of other relevant factors, such as qualification in maths, age and social class. In addition, the subgroups in which the differences were strongest could be specified (using interaction terms). The modelling also allowed for the exploration of a non-linear relationship between performance and maths anxiety. Few quantitative studies in these areas of mathematics education have used a similarly appropriate methodology.

The qualitative strand used a specially developed form of interview which combined features of problem-solving with a life history approach. The interviews were successful in giving the subjects the opportunity to describe crucial experiences with school mathematics and other numerate activities, and to express or exhibit anxiety, or other feelings, about these experiences and/or about the problems presented. They also allowed me to observe and describe numerate thinking processes, and the experiencing of emotions, in a way that was not possible with the questionnaires.

One innovative feature of my interviews was the use of contexting questions (see sec. 9.2.2): the answers to these provided indicators for the practices called up by the subject in response to the problems presented. In most cases these appear to have worked satisfactorily (see Sec. 10.1).

An especially noteworthy feature of the interviews was their use to tap experience with the numerate aspects of a range of practices, rather than attempting a full ethnography of one or two practices at a time (as has been done for example by Carraher et al., Scribner et al., or by Lave et al.). This approach would need to be tested more fully in other studies where it is necessary to judge the practices called up by subjects in order to address problems in various contexts. However, it appears to offer the advantages of being economical with research time, as well as tapping a wide variety of practices in which numerate thinking may be exercised.

This research shows one way of bringing together the quantitative and qualitative styles of research (NOTE 13). It uses their relative strengths: the quantitative aims to produce powerful, general findings based on comparability across subjects and representative samples, and the qualitative aims to produce meaningful accounts grounded in the "richness" and coherence of perspectives of particular subjects. In this study, the quantitative aimed to produce general relationships, at least within a subgroup, e.g. concerning differences in performance scores associated with different measured levels of maths anxiety; the qualitative aimed to give a description of processes whereby thinking and anxiety are produced together in specific contexts for particular subjects.

The two approaches have supported each other. The quantitative allowed certain students' results to be pinpointed as "deviant" - i.e. worthy of further investigation, if their "fit" to the general model was less good than most. (NOTE 7a) The questionnaire threw up surprising answers, e.g. "37.2p" for a restaurant tip, which could be investigated in the interviews. And it provided the sampling frame for choosing a stratified random sample for the interviews. The interview allowed the study of areas that the questionnaire could not - because they required some dialogue in order to produce indicators (e.g. for calling up), because they were highly emotive (e.g. anger, panic), or because they required support for recollection or exploration (e.g. early memories of school or family).

Finally, the interviews were intended to be used with a "data production" rather than a "consciousness raising" aim (Carr-Hill, 1984). However, it is clear from Harriet's remarks that the interview helped her remember experiences with maths and numeracy, including pleasurable ones, and that it was "therapeutic" in allowing her to express herself about a number of past sources of frustration, disappointment and anger. The interviews also allowed the subjects to describe - and to celebrate - their "re-emergence" from maths anxiety and maths blocks, towards facility in numeracy, or sometimes in mathematics itself. (NOTE 13a) The success of these interviews with Harriet and others points to possibilities for using similar interviews in maths anxiety intervention programmes.

12.4 Suggestions for Further Research

A study like this raises many questions for further research. Space allows only a signposting of issues.

To begin with, this study has been about numeracy. Further work would be enriched by considering the relations and parallels between numeracy and various conceptions of literacy (NOTE 14). The discussion might be further developed by considering "statistical literacy" (Haack, 1979), "computer literacy", etc. (NOTE 14a)

Concerning gender differences, the interview analysis suggested a tendency (only) for women to call up school maths (rather than everday practices) more often than men, for a particular problem (tipping); it is worth exploring this possible tendency for a wider range of practical problems. Related to this, we might use the ideas developed here to explore why boys regularly do better than girls, or vice versa, on specific topics in school maths tests - in terms of differences in familiarity with, and in tendency to call up, particular non-school practices; this would likely entail using case studies and larger-scale tests. (NOTE 15)

Following the valuable work using in situ observation (described in Ch.7), there may still be particular practices in which we need to know more about numeracy - especially "more numerate" practices such as those of technicians (cf. Janvier, 1989). Further, the ideas of (multiple) positioning, calling up, etc. need to be developed: this might be done in a replication of the interviews using a sample of non-students. We need more insight into the cognitive aspects (e.g. memory-related) and psychoanalytical aspects of processes highlighted here, especially calling up, misconceptions, "forgetting" (cf. Fairweather, 1991), and the displacement of anxiety onto ideas in practices different to those in which it "originates".

The relationship between "hot" emotions of anger, frustration, anxiety, etc. and "cooler" attitudes of lack of confidence, avoidance, dislike, etc. merits further research (cf. Fennema, 1989). A number of ideas used here need development through studies in other contexts, and with other subjects: e.g. the ideas of confidence and familiarity. In general we need more studies of cognition / affect in mathematical and numerate activity.

Finally, a number of writers on maths difficulties and maths anxiety have raised, explicitly or implicitly, the question: "What's so special about mathematics?" (see e.g. Sec.8.2). Here I have demonstrated that "mathematical" terms may show up in unexpected ways, and that "mathematical" activity and "maths anxiety" can be read in quite different ways. That is, I have shown the complex ways in which the apparently simple and powerful signifiers of mathematics function also as elements in other discourses, thereby producing meaning. Investigation is needed of the ways in which mathematics - in its multiple intersections with, say, mathematics education, computing, marketing, or graphics in television documentaries, etc. - constitutes itself as a field, and how whatever specificity it has is produced, and delimited.

Table 2.1 - Gallup Survey for ACACE: Percentage Correct by Sex, Age and Social Class

		SEX		AGE					CLASS			
	Total	Men	Women	18-24	25-34	35-44	45-64	65+	AB	C1	C2	DE
Base	2,890	1,385	1,505	529	581	493	812	476	463	634	943	848
Question 1	88	89	87	93	92	89	87	81	84	91	88	83
Question 2	74	77	71	70	75	77	76	70	84	83	71	65
Question 3	72	77	67	73	82	79	70	53	91	81	68	58
Question 4	77	87	67	73	83	79	76	70	89	82	78	65
Question 5	68	72	65	66	75	70	67	64	84	77	65	58
Question 6	55	61	50	59	68	63	52	34	79	67	53	37
Question 7	40	45	36	48	51	44	34	28	60	49	36	29
Question 8	70	73	68	73	79	77	69	53	85	77	70	58
Question 9 Time	87	90	83	94	94	91	84	70	95	92	88	76
Question 9 Temp.	72	78	66	82	80	75	68	51	87	79	72	57
Question 9 Both	71	77	65	82	80	74	68	49	86	79	71	56
Question 10	64	68	60	66	68	70	64	51	77	73	64	51

Source: ACACE (1982), Appendix B, p.25

Table 2.2 The NCDS 4th Follow-up (at age 23): Results on the Literacy and Numeracy Questions

	Literacy	Numeracy	Literacy/Numeracy
% reporting problems with	10%	5%	13%
% of men	12%	5%	
% of women	7%	5%	
% of those reporting problems who reported this caused difficulties in everyday life	29%	27%	
% of men	29%	n.a.	
% of women	29%	n.a.	
% of those reporting problems who had attended classes	9%	6%	
% of men	10%	10%	
% of women	5%	2%	

Sources: derived from Simonite (1983) and from Hamilton and Stasinopoulos (1983)

Table 4.1 Presentations of the Questionnaire: Numbers of Respondents

Course / Year	BASS	DipHE QM100	DipHE CM100	Totals
1983	192	124	--	316
1984	136	120	81	328 *
1985	160	55	82	281 *
Totals	488	299	163	935 *

Note: * These totals are adjusted to avoid "double counting" of 9 students in 1984 and 6 students in 1985 who took both QM100 and CM100.

Table 5.1(a) Profiles of 1983 Samples and Whole Sample: Percentages, Means and Standard Deviations

Course		BASS 1983 n=192	DipHE 1983 QM100/n=124	Total 1983 n=316	Whole Sample n=935
SEX (% F)		57	58	58	59
AGE (yrs.)	m	23.1	27.7	24.9	24.8
	sd	6.6	7.0	7.1	7.4
QUAL (% O/A level Maths)		47	34	41	46
PERFS (SM perf.)	m	8.1	8.3	8.1	8.4
	sd	2.0	1.5	1.8	1.7
PERFP (PM perf.)	m	8.5	9.0	8.7	8.9
	sd	2.2	1.8	2.1	1.9
TA (m. test anxiety)	m	4.2	4.2	4.2	4.3
	sd	1.2	1.2	1.2	1.2
NA (num. anxiety)	m	3.0	3.0	3.0	3.1
	sd	0.9	0.9	0.9	1.0
GA (gen. anxiety)	m	3.0	3.0	3.0	3.0
	sd	1.0	0.9	0.9	1.0
CONFSR (self rating)	m	2.7	2.8	2.8	2.8
	sd	0.6	0.6	0.6	0.6
CONFEP (exp. for Poly)	m	1.8	1.8	1.8	1.7
	sd	0.8	0.8	0.8	0.9
DFSM (diffic. in SM)	m	2.0	2.0	2.0	1.9
	sd	0.9	0.9	0.9	0.9
DFED (diffic. in e'day)	m	0.8	0.7	0.7	0.8
	sd	0.8	0.9	0.8	0.8

Table 5.1(b) Profiles of 1984 Samples: Percentages, Means and Standard Deviations

Course		BASS 1984 n=136	DipHE 1984 CM100/n=81	DipHE 1984 QM100/n=120	Total 1984 n=328
SEX (% F)		62	58	51	57
AGE (yrs.)	m	22.7	26.4	28.3	25.5
	sd	6.6	10.5	8.0	8.4
QUAL (% O/A level Maths)		53	41	32	43
PERFS (SM perf.)	m	8.6	8.4	8.8	8.5
	sd	1.4	1.7	1.4	1.5
PERFP (PM perf.)	m	8.8	9.1	9.1	8.9
	sd	2.1	1.9	1.8	2.0
TA (m. test anxiety)	m	4.2	4.6	4.5	4.4
	sd	1.2	1.2	1.1	1.2
NA (num. anxiety)	m	3.0	3.3	3.3	3.2
	sd	1.0	1.0	1.1	1.0
GA (gen. anxiety)	m	2.9	3.1	3.3	3.1
	sd	1.0	1.0	1.0	1.0
CONFSR (self rating)	m	2.7	2.7	2.7	2.7
	sd	0.6	0.7	0.7	0.7
CONFEP (exp. for Poly)	m	1.8	1.0	1.9	1.7
	sd	0.8	0.9	0.9	1.0
DFSM (diffic. in SM)	m	2.0	2.0	1.9	2.0
	sd	0.8	0.9	1.0	0.9
DFED (diffic. in e'day)	m	0.9	0.8	0.8	0.8
	sd	0.7	0.8	0.8	0.8
DFWK (diffic. in work)	m	1.0	1.0	1.0	1.0
	sd	0.7	0.8	0.8	0.8
USED (use in e'day)	m	1.8	1.5	1.6	1.7
	sd	0.7	0.7	0.7	0.7
USWK (use in work)	m	1.8	1.8	1.8	1.8
	sd	0.8	0.7	0.9	0.8

Table 5.1(c) Profiles of 1985 Samples: Percentages, Means and Standard Deviations

Course		BASS 1985 n=160	DipHE 1985 CM100/n=82	DipHE 1985 QM100/n=55	Total 1985 n=291
SEX (% F)		61	71	65	64
SCP (% MC)		51	56	60	54
(% WC)		21	18	24	21
SCS (% NM)		34	45	38	38
(% MAN)		21	26	22	23
AGE (yrs.)	m	23.0	24.5	26.2	23.9
	sd	6.2	6.6	6.6	6.5
QUAL (% O/A level Maths)		51	56	44	52
PERFS (SM perf.)	m	8.4	8.6	7.8	8.4
	sd	1.6	1.5	2.0	1.7
PERFP (PM perf.)	m	9.0	9.2	9.0	9.1
	sd	1.8	1.8	1.6	1.8
TA (m. test anxiety)	m	4.1	4.3	4.0	4.2
	sd	1.3	1.2	1.2	1.2
NA (num. anxiety)	m	3.0	3.2	2.9	3.0
	sd	1.0	1.0	1.1	1.0
GA (gen. anxiety)	m	2.9	3.1	3.1	3.0
	sd	1.0	1.0	0.8	0.9
CONFSR (self rating)	m	2.9	2.8	2.8	2.8
	sd	0.6	0.7	0.6	0.6
CONFEP (exp. for Poly)	m	1.6	0.9	1.7	1.4
	sd	0.8	0.8	0.7	0.9
DFSM (diffic. in SM)	m	1.8	1.5	1.6	1.7
	sd	0.9	1.0	1.0	1.0
DFED (diffic. in e'day)	m	0.9	0.9	0.9	0.9
	sd	0.9	0.9	1.0	0.9
DFWK (diffic. in work)	m	0.8	0.8	0.7	0.8
	sd	0.9	0.8	0.8	0.8
USED (use in e'day)	m	1.8	1.9	1.8	1.8
	sd	0.7	0.7	0.7	0.7
USWK (use in work)	m	2.0	2.0	1.9	2.0
	sd	0.8	0.7	0.8	0.9

Table 5.2 Comparison of Profiles of National Sample (ACACE) and Polytechnic Sample

Sample		National (n= 2890)	Polytechnic (n= 935)
Gender (% Women)		52%	59%
Age (years)	mean	43	24
	s.d.	n.a.	7.4
Social Class (%MC / %WC)		38% / 62%	
(Parental)			58% / 30% **
(Student's Own)			38% / 23% **
Educational Qualification (% 2 A levels or equiv.)		< 40%(est.)*	63% ***

NOTES: * Source of estimate - <u>Social Trends</u>, <u>15</u> (1985), Chart 3.19, p.56.
** based on 1985 sample (n= 291)
*** based on BASS 1985 sample (n= 160)

Table 5.3 Comparison of Results of National Sample (ACACE) and Polytechnic Sample

Percentage correct

Sample Question No. Nat'l (Poly)		Polytechnic (n= 935)	National (n= 2890)	Difference Poly - Nat'l
Question 1 (1)		95	88	+ 7
Question 2 (2)		89	74	+15
Question 3 (18)		65	72	- 7
Question 4 (3)		81	77	+ 4
Question 5 (4)		88	68	+20
Question 6 (-)		--	55	--
Question 7 (14)		67	40	+27
Question 8 (5)		87	70	+17
Question 9A (19)		93	87	+ 6
Question 9B (20)		87	72	+15
Question 10 (6)		64	64	0
Total Correct	mean	8.1	7.1	
	s.d.	1.68	N/A	

Table 5.4(a) Comparison of Results of Qu.10 for the National Sample and Qu.6 for the Polytechnic Sample

Sample / Response	Polytechnic (n= 935)	National (n=2890)
	Percentage Responded	
"three quarters" (correct)	64	64
"a quarter off"	--	7
"a quarter"	32	)
"a half", "a third"	2	) 25
no answer, "don't know"	1	4
	99	100

Note: For the formats of the questions, see Fig. 5.1(a) (p.464).

Table 5.4(b) Comparison of Results of Qu.3 for the National Sample and Qu.18 for the Polytechnic Sample

Sample / Response	Polytechnic (n= 935)	National (n=2890)
	Percentage Responded	
"37p", "37 1/2p", "38p" (correct)	65	
/ "35p", "36p" (correct)		72
"35p", "36p", "39p", "40p"(approx.)	3	
/ "about 30p - 40p"		0
other, wrong	7	) 19
"37.2p"	13	)
no answer, "don't know"	11	9
	99	100

Note: For the formats of the questions, see Fig 5.1(b) (p 464).

Table 5.5 Comparisons of Performance among Polytechnic Students across Questions of Several Types: Percentage Correct

Type of Context / Type of Operation	Pract. Maths /money		School Maths /arithmetic		School Maths /algebra	
Addition	(Qu.1)	95	(Qu.7)	98	(Qu.11)	94
Subtraction	(Qu.5)	87	(Qu.8)	**78	--	--
Multiplication	(Qu.2)	89	(Qu.10)	91	(Qu.12)	88
Division	(Qu.4)	88	(Qu.9)	***90	(Qu.13)	*78/93

NOTES: * for 1983 and 1984/85 versions of item respectively
** for 1985 version of item only
*** for 1983 and 1985 versions of item only
For different versions of items, see APPENDIX Q8.

Table 5.6 Gender Differences for Main Outcome Variables: Hypotheses, Summary Statistics and Observed Differences for Whole Sample

Variable	Hypothesis		Females (n=555)	Males (n=378)	Difference (in exp. dir'n)	
AGE (% 21+)	F > M		64	64	0	
(yrs.)		m	24.8	24.8		
		sd	7.4	7.5		
QUAL(% O/A level Maths)	M > F		41	54	13	p<.001
PERFS (SM performance)	M > F	m	8.07	8.78	0.71	p<.001
		sd	1.69	1.53	.11	
PERFP (PM performance)	M > F	m	8.67	9.24	0.57	p<.001
		sd	1.93	1.91	.13	
TA(maths test anxiety)	F > M	m	4.47	3.94	0.53	p<.001
		sd	1.22	1.12	.08	
NA(numerical anxiety)	F > M	m	3.15	2.91	0.24	p<.001
		sd	1.00	.91	.07	
GA (general anxiety)	F > M	m	3.05	3.00	0.05	F ≅ M
		sd	.99	.93	.07	
MA37 (state anxiety)	F > M	m	3.33	2.89	0.44	p<.001
		sd	1.63	1.54	.11	
ETA(Engl. test anxiety)	-	m	3.36	3.39	0.03	F ≅ M
		sd	1.54	1.44	.10	
CONFSR (self rating)	M > F	m	2.63	2.95	0.32	p<.001
		sd	.65	.581	.04	
DFSM (diffic. in SM)	F > M	m	1.52	1.39	0.13	p≅.05
		sd	1.05	1.04	.07	
DFED (diffic. in everyday)	-	m	1.34	1.07	0.27	(F > M)
		sd	1.02	.97	.07	
DFWK (diffic. in work)	-	m	1.00	0.69	0.31	(F > M)
		sd	.84	.71	.06	
USED (use in everyday)	-	m	1.70	1.78	0.08	F ≅ M
		sd	.68	.74	.05	
USWK (use in work)	-	m	1.86	1.89	0.03	F ≅ M
		sd	.78	.89	.06	

Table 5.7 Relationship between Parental Occupation (SCP) and Own Occupation (SCS): Crosstabulation for 1985 Sample - Counts and Row Percentages (n=291)

Parental Occupation (SCP)		Student's Own Occupation (SCS) (NM) Non-Manual (n=111)	Manual (MAN) (n=66)	No Occ. to date (n=106)	No Resp. (n=8)	Total
Middle Class (MC)	n	55	42	58	1	156
		35%	27%	37%	1%	100%
Mixed	n	15	6	15	2	38
		40%	16%	40%	2%	101%
Working Class (WC)	n	31	10	19	1	61
		51%	16%	31%	2%	100%
No Resp.	n	10	8	14	4	36
		28%	22%	38%	11%	99%

Note: Percentages are rounded and therefore sometimes fail to sum to exactly 100%.

Table 5.8 Parental Occupation (SCP) Differences for Main Outcome Variables: Hypotheses, Summary Statistics and Observed Differences for 1985 Sample

Variable	Hypothesis		Middle Class (n=156)	Mixed (n=38)	Working Class (n=61)	Diff'ce (in exp. dir'n)
SEX (% male)	-		39	21	41	2
AGE (% 21+)	MC < WC		56	54	69	13
QUAL(% O/A level Maths)	MC > WC		61	42	47	14 p≅.05
PERFS (SM performance)	MC >> WC	m	8.58	7.95	8.36	0.22 ns
		sd	1.70	1.56	1.73	.26
PERFP (PM performance)	MC > WC	m	9.23	8.84	9.13	0.10 ns
		sd	1.73	1.87	1.71	.27
TA(maths test anxiety)	MC < WC	m	4.22	4.47	4.01	- 0.21
		sd	1.29	1.21	1.10	MC > WC
NA(numerical anxiety)	MC < WC	m	3.09	3.17	2.91	- 0.18
		sd	1.07	.93	.92	MC > WC
GA (general anxiety)	MC < WC	m	3.05	3.02	2.95	- 0.10
		sd	.98	.89	.81	MC > WC
CONFSR (self rating)	MC > WC	m	2.82	2.66	2.87	- 0.05
		sd	.67	.58	.04	MC ≅ WC
DFSM (diffic. in SM)	MC < WC	m	1.67	1.92	1.67	0
		sd	.99	.85	.98	MC = WC

Table 5.9 Parental Occupation (SCP) Differences for Selected Outcome Variables by Gender: Summary Statistics for 1985 Sample (n=217*)

Variable		Males		Females	
		Middle Class (n=61)	Working Class (n=25)	Middle Class (n=95)	Working Class (n=36)
QUAL(% O/A Maths)		72%	56%	52%	40%
PERFS (SM performance)	m	9.02	9.04	8.30	7.89
PERFP (PM performance)	m	9.71	9.60	8.93	8.81
CONFSR (self rating)	m	3.01	3.04	2.70	2.75

Note: * This table excludes 38 students who were classified as having "mixed" parental occupation, and 36 others for whom information on one of the main variables was missing.

Table 5.10 Student's Own Occupation (SCS) Differences for Main Outcome Variables: Hypotheses, Summary Statistics and Observed Differences for 1985 Sample (n = 291)

Variable	Hypothesis		(NM) Non -Manual (n=111)	Manual (MAN) (n=66)	No Occ. to date (n=106)	Diff'ce (in exp. dir'n)
GENDER (%M)	-		28	55	33	- 27
AGE (% 21+)	-		79	59	40	- 20
QUAL(% O/A level Maths)	NM ≅ MAN		53	53	60	0
PERFS (SM performance)	NM ≅ MAN	m	8.18	8.58	8.45	- 0.40
		sd	1.84	1.61	1.60	(NM < MAN)
PERFP (PM performance)	NM > MAN	m	9.04	9.29	9.03	- 0.25
		sd	1.85	1.72	1.75	NM < MAN
TA(maths test anxiety)	NM ≅ MAN	m	4.31	4.04	4.08	0.27
		sd	1.25	1.22	1.24	(NM > MAN)
NA (numer. anxiety)	NM < MAN	m	3.10	2.95	3.02	- 0.15
		sd	.99	.90	1.11	NM > MAN
GA (general anxiety)	-	m	3.07	2.95	3.02	0.12
		sd	.93	.91	.99	NM ≅ MAN
CONFSR (self rating)	NM ≅ MAN	m	2.73	2.85	2.91	0.12
		sd	.65	.61	.64	(NM < MAN)
DFSM (diffic. in SM)	NM ≅ MAN	m	1.74	1.61	1.67	0.13
		sd	.97	1.02	.94	NM ≅ MAN
DFWK (diff. in work)	NM < MAN	m	0.85	0.67	0.80	- 0.22
		sd	.76	.79	.91	NM > MAN
USWK (use in work)	NM > MAN	m	1.99	2.06	1.86	- 0.07
		sd	.81	.74	.83	NM ≅ MAN

Table 5.11 Age Differences for Main Outcome Variables: Hypotheses, Summary Statistics and Observed Differences for Whole Sample

Variable	Hypothesis		Age Groups Younger (18-20) n=333	Intermed. (21-24) n=249	Older (25+yrs.) n=344	Diffs. (in exp. dir'n)
GENDER (%M)			41	41	41	0 / 0
QUAL(% O/A level Maths)	Y> I> O		65	41	32	24 / 9
PERFS (SM performance)	Y>> I> O	m	8.82	8.10	8.12	0.72 / 0
		sd	1.232	1.766	1.856	.13(max.) Y >> I=O
PERFP (PM performance)	Y> I> O	m	9.15	8.54	8.92	.61/-.38
		sd	1.641	2.170	1.975	.17(max.) Y> I < O
TA(m. test anxiety)	Y<<I<<O	m	4.03	4.22	4.48	.19 /.26
		sd	1.174	1.112	1.258	.10(max.) Y< I < O
NA (numer. anxiety)	Y< I< O	m	2.92	3.08	3.18	.16 /.10
		sd	0.916	0.938	1.025	.08(max.) Y < I≤O
GA (general anxiety)	-	m	2.94	2.97	3.14	.03 /.17
		sd	0.959	0.955	0.970	Y=I < O
CONFSR(self rating)	Y> I> O	m	2.92	2.74	2.62	.18 /.12
		sd	0.565	0.643	0.672	.05(max.) Y> I > O
USWK (use in work)	Y< I< O	m	1.88	1.81	1.90	-.07/.09
		sd	0.81	0.80	0.86	Y≅I≅O
USED (use in everyday)	Y< I< O	m	1.75	1.73	1.71	0 / 0
		sd	0.67	0.77	0.69	Y≅I≅O

Table 5.12 Differences related to Maths Qualification in Selected Variables: Summary Statistics for Whole Sample (n=935 *)

Qualification in Maths / Variable		None (n=214)	CSE (n=211)	O-level (n=383)	A-level (n=42)
GENDER (% Male)		35	35	46	57
AGE (years)	m	30.1	22.5	23.1	21.8
	sd	8.2	4.7	6.3	6.6
PERFS (SM performance)	m	7.53	8.13	8.95	9.50
	sd	1.96	1.59	1.25	0.74
PERFP (PM performance)	m	8.50	8.48	9.42	9.55
	sd	1.66	1.98	1.60	0.82
TA (maths test anxiety)	m	4.77	4.58	3.86	3.30
	sd	1.10	1.08	1.18	1.02
NA (numerical anxiety)	m	3.07	3.09	3.02	2.86
	sd	0.98	0.99	0.94	0.76
GA (general anxiety)	m	3.00	2.92	3.05	3.18
	sd	0.99	0.97	0.97	0.84
CONFSR (self rating in SM)	m	2.36	2.58	3.01	3.42
	sd	0.59	0.56	0.54	0.61
DFSM (diffic. in SM)	m	1.66	1.67	1.34	0.98
	sd	1.18	1.01	.99	.78

* Note: The results of students coded as "Other Qualification" or "No Response" were not included here.

Table 5.13 Relationships between Performance and Maths Anxiety: Hypotheses and Correlations for Whole Sample (n = 935)

Variables	Hypothesis	Observed Correlation
PERFS w. TA	r < 0 and greater	-.32
(numerically) than		
PERFS w. NA	r < 0	-.25
PERFP w. NA	r < 0 and greater	-.21
(numerically) than		
PERFP w. TA	r < 0	-.20

Table 5.14 Relationships between Performance and Selected Affective Variables: Hypotheses and Correlations for Whole Sample (n = 935)

Variables	Hypothesis	Observed Correlation
PERFS w. CONFSR	r > 0 and greater	.45
(numerically) than		
PERFP w. CONFRS	r > 0	.27
PERFS w. DFSM	r < 0 and greater	-.16
(numerically) than		
PERFP w. DFSM	r < 0	-.18
PERFP w. USED, USWK	both r > 0 and greater	.11, .12
(numerically) than		
PERFS w. USED, USWK	both r > 0	.16, .17
PERFP w. DFED, DFWK	both r < 0 and greater	-.26,-.23
(numerically) than		
PERFS w. DFED, DFWK	both r < 0	-.33,-.25

Table 6.1 Tentative Classification of Polytechnic Mathematics Anxiety Items within Maths Test Anxiety and Numerical Anxiety Dimensions

Dimension	Subdivision
Maths Course / Test Anxiety	maths course anxiety (4 items): Qus.3, 4, 15, 28
	maths class anxiety, active (2): Qus. 18, 23
	maths class anxiety, passive (4): Qus. 8,9,13,20
	maths evaluation anxiety (3): Qus. 25, 31, 35
Numerical Anxiety	money, immediate (4 items): Qus. 1, 14, 22, 24
	money, planning (5): Qus.5, 17, 19, 27, 33
	context unspecified (4): Qus. 6, 10, 11, 30

NOTE: For wording of items, see Appendix Q1.

Table 6.2(a) Three-Factor Principal Factor Analysis (PFA) of Mathematics Anxiety Items, using (i) Varimax and (ii) Oblimin Rotations: Factor Loadings (cut to 2 decimal places)

(i) Varimax	Factor 1	Factor 2	Factor 3
T25	.76	(.31)	
T18	.73	(.34)	
T31	.62	(.31)	
T23	.57		
T35	.56		
N10	.52		(.38)
T8	(.34)	.69	
T15	.44	.65	
T13	(.36)	.61	
T20	(.33)	.61	
T3	.48	.60	
T9	(.35)	.60	
T4		.56	(.32)
T28	.51	.55	
N22			.67
N5			.65
N33			.62
N27			.61
N11			.59
N14	(.31)		.56
N1			.56
N19	(.37)		.47
N17			.47
N30	(.38)	(.36)	.46
N24	.41		.43
N6		(.34)	.42

(ii) Oblimin	Factor 1	Factor 2	Factor 3
T25	.69		
T18	.63		
T31	.53		
T35	.47		
T23	.46		
N10	(.38)		(.31)
T8		.81	
T15		.72	
T13		.68	
T20		.67	
T9		.66	
T3		.66	
T4		.64	
T28		.57	
N22			.73
N33			.68
N5			.65
N27			.63
N14			.60
N11			.57
N1			.57
N17			.49
N19			.48
N30			(.38)
N24			(.37)
N6		(.32)	(.35)

Table 6.2(b) Three-Factor Maximum Likelihood Factor Analysis (MLFA) of Mathematics Anxiety Items, using (i) Varimax and (ii) Oblimin Rotations: Factor Loadings (cut to 2 dec. pl.)

(i) Varimax	Factor 1	Factor 2	Factor 3
T25	.77	(.30)	
T18	.71	(.35)	
T31	.64		
T35	.57		
T23	.55		
N10	.53		(.38)
T28	.53	.53	
N24	.43		.43
T8	(.33)	.70	
T15	.44	.65	
T20	(.31)	.63	
T13	(.35)	.63	
T9	(.35)	.60	
T3	.50	.57	
T4		.54	(.33)
N22			.67
N5			.65
N33			.61
N27			.61
N11			.60
N1			.56
N14			.56
N30	.40	(.32)	.48
N17			.47
N19	(.36)		.46
N6		(.30)	.44

(ii) Oblimin	Factor 1	Factor 2	Factor 3
T25	.77		
T18	.66		
T31	.60		
T35	.53		
T23	.47		
N10	.45		(.30)
T8		.82	
T20		.71	
T15		.70	
T13		.69	
T9		.65	
T4		.62	
T3	(.30)	.58	
T28	(.35)	.51	
N22			.73
N33			.67
N5			.67
N27			.63
N11			.60
N1			.58
N14			.57
N17			.48
N19			.45
N30			.40
N6			(.38)
N24	(.33)		(.37)

Table 6.2(c) Three-Factor Alpha Factor Analysis (AFA) of Mathematics Anxiety Items, using (i) Varimax and (ii) Oblimin Rotations: Factor Loadings (cut to 2 decimal places)

(i) Varimax	Factor 1	Factor 2	Factor 3
T25	.79		
T18	.79		
T31	.65		
T23	.62		(.31)
T28	.61	.44	
T15	.59	.52	
T35	.59		
T3	.58	.52	
N10	.53		(.38)
T13	.52	.46	
T9	.49	.49	
T20	.49	.46	
N24	.43		.42
T8	.52	.54	
T4		.51	
N6		.42	(.38)
N22			.67
N33			.63
N5			.62
N27			.60
N14	(.32)		.58
N11			.56
N1			.56
N19			.47
N17	(.36)		.46
N30		(.30)	.44

(ii) Oblimin	Factor 1	Factor 2	Factor 3
T3	.83		
T15	.80		
T28	.80		
T8	.79		
T25	.79		
T18	.77		
T13	.69		
T9	.68		
T31	.68		
T20	.66		
T35	.61		
T23	.54		
N10	.51		
T4	.47		
N30	.45		(.34)
N24	(.39)		(.34)
N22			.75
N33			.70
N5			.66
N27			.63
N14			.59
N1			.56
N11			.56
N17			.49
N19			.48
N6			(.33)

Table 6.2(d) Three-Factor Analysis: Mathematics Anxiety Items Associated with each Factor

Factor 1 : normally 8 to 10 items
* maths evaluation anxiety - 3 of 3 items: T25, T31, T35;
* maths class anxiety, "active" - 2 of 2 items: T18, T23;
* numerical anxiety, context unspecified - only 2 of 4:
N30 - Being given a set of numerical problems involving addition to solve on paper;
N10 - Having someone watch you as you total up a column of figures;
* numerical anxiety, money context, immediate - only 1 of 4:
N24 - Figuring out VAT at 15% on a purchase which costs more than £1;
* (some results only) maths course anxiety - 2 of 4 items:
T3 - Enrolling for a course which includes a compulsory mathematics component;
T28 - Realising that you have to do a certain number of maths classes in order to complete your degree;

Factor 2 : normally 8 items
* maths class anxiety, passive - 4 of 4 items: T8, T9, T13, T20;
* maths course anxiety items - 4 of 4 items: T3, T4, T15, T28;

Factor 3 : normally 10 to 12 items
* numerical anxiety, money context, immediate and planning - 8 of 9 items: N1, N15, N14, N17, N19, N22, N27, N33;
* numerical anxiety context unspecified - 2 of 4 items:
N11 - Adding 976 + 777 on paper;
N6 - Dividing a five digit number by a two digit number in private with pencil and paper.
* (some results only) numerical anxiety, context unspecified
N30 - Being given a set of numerical problems involving addition to solve on paper;
* (some only) numerical anxiety, money context, immediate:
N24 - Figuring out VAT at 15% on a purchase which costs more than £1.

NOTE: For the full wording of all items, see APPENDIX Q1.

Table 6.3(a) Two-Factor Principal Factor Analysis (PFA) of Mathematics Anxiety Items, using (i) Varimax and (ii) Oblimin Rotations: Factor Loadings (cut to 2 decimal places)

(i) Varimax	Factor 1	Factor 2
T18	.75	
T15	.75	
T3	.75	
T25	.75	
T28	.75	
T8	.70	
T13	.67	
T31	.66	
T9	.65	(.30)
T20	.64	(.30)
T35	.61	
T23	.59	(.31)
N10	.57	(.39)
N30	.51	.48
N24	.48	.44
T4	.47	(.35)
N22		.68
N5		.66
N27		.62
N33		.62
N11		.61
N1		.57
N14		.56
N17		.47
N19	(.35)	.47
N6	(.31)	.44

(ii) Oblimin	Factor 1	Factor 2
T25	.84	
T18	.82	
T3	.82	
T28	.80	
T15	.79	
T8	.76	
T31	.71	
T13	.68	
T9	.66	
T20	.65	
T35	.64	
T23	.59	
N10	.53	
N30	.42	(.36)
T4	.42	
N24	.40	(.32)
N22		.77
N5		.71
N33		.66
N27		.64
N11		.60
N1		.58
N14		.54
N17		.47
N19		.41
N6		(.39)

Table 6.3(b) Two-Factor Maximum Likelihood Factor Analysis (MLFA) of Mathematics Anxiety Items, using (i) Varimax and (ii) Oblimin Rotations: Factor Loadings (cut to 2 dec. pl.)

(i) Varimax	Factor 1	Factor 2
T15	.76	
T3	.76	
T25	.75	
T28	.75	
T18	.75	
T8	.70	
T13	.67	
T31	.66	
T9	.65	(.30)
T20	.64	(.31)
T35	.60	
T23	.59	(.30)
N10	.57	(.39)
N30	.50	.49
N24	.48	.44
T4	.47	(.36)
N22		.68
N5		.66
N27		.62
N33		.61
N11		.61
N1		.57
N14		.56
N17		.47
N19	(.35)	.46
N6	(.31)	.45

(ii) Oblimin	Factor 1	Factor 2
T25	.84	
T3	.82	
T18	.81	
T28	.81	
T15	.79	
T8	.75	
T31	.71	
T13	.69	
T9	.66	
T20	.65	
T35	.64	
T23	.59	
N10	.52	
T4	.43	
N30	.42	(.37)
N24	.40	(.32)
N22		.77
N5		.71
N33		.66
N27		.64
N11		.61
N1		.58
N14		.54
N17		.47
N19		.41
N6		.40

Table 6.2(c) Two-Factor Alpha Factor Analysis (AFA) of Mathematics Anxiety Items, using (i) Varimax and (ii) Oblimin Rotations: Factor Loadings (cut to 2 decimal places)

(i) Varimax	Factor 1	Factor 2
T18	.76	
T3	.75	
T15	.75	
T25	.75	
T28	.74	
T8	.71	
T13	.66	
T31	.66	
T9	.65	(.30)
T20	.64	(.30)
T35	.61	
T23	.59	(.31)
N10	.57	.40
N30	.52	.48
N24	.47	.44
T4	.47	(.35)
N22		.69
N5		.66
N33		.62
N27		.62
N11		.60
N1		.57
N14		.56
N19	(.34)	.48
N17		.48
N6	(.31)	.43

(ii) Oblimin	Factor 1	Factor 2
T25	.83	
T18	.82	
T3	.82	
T28	.80	
T15	.79	
T8	.76	
T31	.72	
T13	.68	
T9	.66	
T20	.65	
T35	.64	
T23	.58	
N10	.53	
N30	.42	(.35)
T4	.42	
N24	.40	(.33)
N22		.77
N5		.71
N33		.66
N27		.64
N11		.59
N1		.58
N14		.55
N17		.48
N19		.42
N6		(.38)

Table 6.4 Models for TA and NA: Variables Included, Regression Equations, and Estimates of Effects for 1985 Sample (n = 232 and 220, respectively *)

Outcomes	TA - Maths Test Anxiety	NA- Numerical Anxiety
Predictors Included	QUAL	QUAL
	SEX	SEX
	AGE3 - AGE2, AGEQ	AGE3 - AGE2, AGEQ
	SCP - SCP1, SCP2	SCP - SCP1, SCP2
	SCS - SCS1, SCS2	SCS - SCS1, SCS2
	DFSM	DFED
		DFWK

Regression Equations

TA = 2.86 -.40 QUAL +.49 SEX +.23 AGE2 +.18 AGEQ
-.04 SCP1 -.27 SCP2 -.01 SCS1 +.16 SCS2 +.60 DFSM
R-squared = 38.3%

NA = 2.52 -.24 QUAL +.09 SEX +.22 AGE2 +.35 AGEQ
-.21 SCP1 -.48 SCP2 -.08 SCS1 +.04 SCS2
+.38 DFED + .19 DFWK
R-squared = 30.1%

Estimates of Effects	for TA	for NA
Qualification in Maths	.40 scale pt.	.24 scale pt.
(high qual., less anx.)	(.15 **)	(.13)
Gender	.49	.09
(women more anxiety)	(.14)	(.13)
Age: 21-24 comp. with 18-20	.05	-.13
(older, more anxiety)	(.17)	(.16)
25+ comp. with 18-20	.23	.22
(older, more anxiety)	(.17)	(.17)
Parents: MC comp. with WC	.23	.27
(middle class, more anx.)	(.15)	(.14)
Own Occ.: NM comp. with MAN	.15	.12
(manual occ., more anxiety)	(.18)	(.17)
Difficulty with SM courses	.60	--
	(.07)	
Difficulty with using numbers in everyday life	--	.38
		(.08)
Difficulty with using numbers in work	--	.19
		(.09)

Note: * Only cases for which no variable score was missing were included in regression analyses.
** Standard Errors are given in parentheses for the estimate of each effect.

Table 6.4(a) Models for Maths Test Anxiety (TA) and Numerical Anxiety (NA): Variables Included, Regression Equations and Estimates of Effects for Whole Sample (n=849*)

Outcomes	TA - Maths Test Anxiety	NA- Numerical Anxiety
Predictors Included	QUAL SEX AGE3 - AGE2, AGEQ2 YEAR - YR1 only SAMPLE - SA2 only DFSM	QUAL SEX AGE3 - AGE2, AGEQ YEAR - YR1 only SAMPLE - SA2 only DFED

Regression Equations

TA = 3.59 -.61 QUAL +.40 SEX +.25 AGE2 +.22 AGEQ
-.12 YR1 -.20 SA2 +.41 DFSM R-squared = 28.5%

NA = 2.80 -.26 QUAL +.14 SEX +.06 AGE2 +.07 AGEQ
+.34 YR1 -.40 SA2 +.36 DFED R-squared = 18.7%

Estimates of Effects	for TA	for NA
Qualification in Maths (high qual., less anx.)	.61 scale point (.08 **)	.26 scale point (.07)
Gender (women more anxiety)	.40 (.07)	.14 (.06)
Age: 21-24 comp. with 18-20 (older, more anxiety)	.04 (.09)	-.00 (.08)
25+ comp. with 18-20 (older, more anxiety)	.25 (.09)	.06 (.07)
Difficulty with SM courses	.41 (.04)	--
Difficulty with using numbers in everyday life	--	.35 (.03)

Note: * Only cases for which no variable score was missing were included in regression analyses.
** Standard Errors are given in parentheses for the estimate of each effect.

Table 6.5 Models for School Maths Performance (PERFS): Variables Included, Regression Equations, and Estimates of Effects for Whole Sample (n = 837*) and 1985 only (n = 217*)

Outcomes	PERFS - Whole Sample	PERFS - 1985 only
Predictors Included	QUAL, SEX, AGE2	QUAL, SEX, AGE2
	YEAR - YR1 only	SCP - SCP1, SCP2
	SAMPLE - SA1 only	SCS - SCS1, SCS2
	QUAL x AGE2	QUAL x AGE2
	SEX x AGE2	SEX x AGE2
	AGE2 x SAMPLE - A2xSA1	QUAL x SEX
	TA, TASQ, CONFSR	TA, TASQ, CONFSR

Regression Equations

PERFS = 5.64 +.23 QUAL -.16 SEX -.02 AGE2 +.51 QxA2
(Whole Sample) -.41 SxA2 +.30 YR1 +.30 SA1 -.63 A2xSA1 +.43 TA -.06 TASQ +.74 CONFSR
R-sq. = 29.1%

PERFS = 5.92 -.51 QUAL -.62 SEX -.37 AGE2 +1.11 QxS
(1985 Sample) +.87 QxA2 -.84 SxA2 +.43 SCP1 +.15 SCP2 -.07 SCS1 +.09 SCS2 +.77 TA -.11 TASQ +.61 CONFSR
R-sq.= 39.7%

Estimates of Effects	PERFS - Whole Sample		PERFS - 1985	
			Male	Female
Qualif.: if Younger(18-20)	.23 question		-.51	.61
(high qual., higher perf.)	(.18)		(.43)	(.35)
if Mature (21+)	.74		.36	1.48
	(.14)		(.39)	(.31)
			Hi Qual	Lo Qual
Gender: if Younger (18-20)	.16		-.50	.62
(men, higher perf.)	(.17)		(.30)	(.42)
if Mature (21+)	.57		.34	1.46
	(.13)		(.35)	(.35)
	BASS	DipHE		
Age: if High-Qualified Male	.13	-.49	-.50	
(younger, higher perf.)	(.23)	(.23)	(.35)	
if High-Qualified Female	.54	-.09	.34	
	(.22)	(.22)	(.31)	
if Low-Qualified Male	.65	.02	.37	
	(.25)	(.25)	(.43)	
if Low-Qualified Female	1.05	.43	1.21	
	(.22)	(.22)	(.34)	
Parents: MC comp. with WC	--		.28	
(middle class, higher perf.)			(.21)	
Own Occ.: NM comp. with MAN	--		.15	
(manual occ., higher perf.)			(.25)	
Confidence (Self-rating in SM)	.74		.61	
	(.10)		(.20)	

Note: * Only cases for which no variable score was missing were included in regression analyses.

Table 6.6 Models for Practical Maths Performance (PERFP): Variables Included, Regression Equations, and Estimates of Effects for Whole Sample (n = 853*)

Outcome	PERFP - Whole Sample
Predictors Included	QUAL SEX AGE3 - AGE2, AGEQ SAMPLE - SA1 only AGE3 x SAMPLE - A2xSA1 AQxSA1 only NA NASQ DFED

Regression Equation

PERFP = 7.98 +.69 QUAL -.27 SEX +.53 AGE2 +.96 AGEQ
+1.18 SA1 -1.02 A2xSA1 -1.12 AQxSA1
+.47 NA -.12 NASQ -.31 DFED

R-squared = 16.9%

Estimates of Effects	for PERFP	
Qualification in maths:	.69 question	
(high-qualified, higher performance)	(.13**)	
Gender:	.27	
(men, higher performance)	(.13)	
	BASS	/ DipHE
Age: 21-24 comp. with 18-20	.33	.43
(younger, higher perf.)	(.21)	(.26)
25+ comp. with 18-20	.49	-.53
(younger, higher perf.)	(.21)	(.23)
Difficulty with using	-.31	
numbers in everday life	(.07)	

Note: * Only cases for which no variable score was missing were included in regression analyses.
** Standard Errors are given in parentheses for the estimate of each effect.

Table 7.1 Levels of Reasoning Strategy Coded in Best-buy Studies of Capon and Kuhn

(1) extraneous, task-extrinsic: e.g. "I always buy the large sizes, since I don't like to shop often."
(2) extraneous, task-intrinsic: e.g. "I always buy the large sizes (or those marked 'reduced'), since they must be cheaper."
(3) partial, non-inferential: e.g "Four ounces added to the smaller jar equals half more."
(4) subtraction / difference: e.g. "With the larger one, you get 32 more grams for 36c more, so it's a better buy."
(5) calculation and comparison of the quantity and price ratios of two products: e.g. "Twice as much for less than twice the price - the big one is cheaper."
(6) calculation and comparison of "direct (unit price) ratios": e.g. "The small one is 17c per oz., and the large one is 17 1/2c, so the small one is a better buy".

Source: Capon and Kuhn (1979, 1982)

Table 10.1 Positionings for Interview Qu.2 [10% of 6.65] and for Interview Qu.4 [10% tip on meal "chosen" from menu]: Cross-tabulation of Numbers of Subjects

		Positioning for Question 4 in Interview		
		School Maths (SM)	Tipping Practices (PM)	Total
Positioning for Qu.2 in Interview	SM	5	12	17
	PM	0	6	6
	Total	5	18	23

Note: This Table excludes 2 of the 25 subjects for whom either response is not available.

Table 10.2 Positionings for Questionnaire Qu.18 [10% tip on restaurant bill of £3.72] and for Interview Qu.4 [10% tip on meal "chosen" from menu]: Cross-tabulation of Numbers of Subjects

		Positioning for Question 4 in Interview		
		School Maths (SM)	Tipping Practices (PM)	Total
Positioning for Qu.18 on Q're	SM	1	5	6
	Tipping (PM)	4	10	14
	Total	5	15	20

Note: This Table excludes 5 of the 25 subjects for whom either interview or questionnaire response is not available.

Table 10.3(a) Performance on Interview Qu.2 [10% of 6.65]: Cross-tabulation of Number Correct by Gender and Parental Social Class

Parents	Men	Women	Total
Middle Class	5 of 5	4 of 6 (1 approx., 1 refusal)	9 of 11
Mixed Class	0 of 1 (1 approx.)	0 of 2 (2 wrong)	0 of 3
Working Class	4 of 4	2 of 4 (1 approx., 1 wrong)	6 of 8
Total	9 of 10	6 of 12	15 of 22

Note: This Table excludes two of the 25 subjects who were not asked to attempt Qu.2, and one whose response could not be classified as correct or not.

Table 10.3(b) Performance on Interview Qu.2 [10% of 6.65]: Cross-tabulation of Number Correct by Gender, Qualification in Maths, and Positioning in School Maths or Practical Maths

Qualif. in Maths (Positioning)	Men	Women	Total
O/A level	4 of 5	3 of 4	7 of 9
(SM)	(3 of 4; 1 approx.)	(2 of 3; 1 refusal)	(5 of 7)
(PM)	(1 of 1)	(1 of 1)	(2 of 2)
CSE / None	5 of 5	3 of 8	8 of 13
(SM)	(3 of 3)	(2 of 6; 1 approx., 3 wrong)	(5 of 9)
(PM)	(2 of 2)	(1 of 2; 1 approx.)	(3 of 4)
Total	9 of 10	6 of 12	15 of 22

Note: 1. This Table excludes two of the 25 subjects who were not asked to attempt Qu.2, and one whose response could not be classified as correct or not.
2. For the indicators of SM and PM positioning, see the text.

Table 10.4 Performance on Interview Qu.3 [reading graph of gold price]: Cross-tabulation of Number with Both Parts Correct by Gender, Qualification in Maths and Positioning

Qualif. in Maths	Men	Women		Total (Positioning)
O/A level	3 of 5 (1 Ax, 1 Bx)	2 of 4 (1 Bx, 1 A&Bx)		5 of 9
			(SM)	(5 of 7)
			(PM)	(0 of 2)
CSE / None	4 of 6 (2 Bx)	2 of 8 (2 Ax, 1 Bx, 3 A&Bx)		6 of 14*
			(SM)	(5 of 11)
			(PM)	(0 of 2)
Total	7 of 11	4 of 12		11 of 23

Ax = Part A incorrect and Part B correct
Bx = Part A correct and Part B incorrect
A&Bx = Parts A and B both incorrect

Note: This Table excludes two of the 25 subjects who were not asked to attempt Qu.2.
* For the breakdown of the CSE / no qualification group, one subject whose positioning could not be classified was excluded.

Table 10.5 Performance on Interview Qu.4B [10% tip on menu]: Cross-tabulation of Number Correct by Gender, Positioning and Tipping Rule Enunciated

Positioning / Rule for Tipping	Men	Women	Total
PM: Percentage - 10%, 15%, etc.	4 of 4	2 of 2	6 of 6
PM: Amount - eg 50p, £1, £1.50, etc.	1 of 2 (1 "wrong")	0 of 1 (1 "wrong")	1 of 3
PM: Rounding up to nearest 50p, etc.	3 of 3	4 of 4	7 of 7
PM: No tip	2 of 2	--	2 of 2
SM	--	3 of 5 (1 unfin., 1 refusal)	3 of 5
Total	10 of 11	9 of 12	19 of 23

Note: This Table excludes two of the 25 subjects who were not asked to attempt Qu.4.

Table 10.6 Performance on Interview Qus.5A and 5B [9% wage increase, approximately and precisely] Cross-tabulation of Number Correct etc. by Gender and Positioning for Both Parts

Pos'ning	Part	Men	Women	Total
PM on A,	A	close: 2 of 3	close: 3 of 7	
SM on B		apprx: 1	apprx: 3	
			ref: 1	
	B	corr: - of 3	corr: 1 of 7)	1 of 10
		dec: 1	)	
		setup: 1	setup: 2	
		ref: 1	ref: 4	
				3M, 7F
PM on A,	A	close: 2 of 3	close: 2 of 2	
PM on B		xx: 1		
	B	corr: 2 of 3	corr: 2 of 2)	4 of 5
		calc: 1	)	
				3M, 2F
SM on A,	A	close: - of 1	close: - of 1	
SM on B		xx: 1	xx: 1	
	B	corr: - of 1	corr: - of 1)	0 of 2
		dec: 1	)	
			ref: 1	
				1M, 1F
Total	A	close: 4 of 7	close: 5 of 10	9 of 17
		apprx: 2	apprx: 3	
		xx/ref 1	xx/ref 2	
	B	corr: 2 of 7	corr: 3 of 10	5 of 17
		dec: 2		
		calc: 1		
		setup: 1	setup: 2	
		ref: 1	ref: 5	
				7M, 10F

Note: For response A: close = £6 to £7; apprx = £4 to £5; xx = wrong; ref = refusal to answer.
For response B: corr = correct; dec = misplaced dec. pt. calc = calcul'n error; setup = wrong operation (÷, not x).
This Table excludes eight of the 25 subjects who were not asked to attempt Qu.5.

Table 10.7(a) Strategies Used for Solving Best-buy problems: a comparison of two simulation studies, supermarket observation, and interviews in this study

Strategies	Capon and Kuhn Simulation k=2 problems	Lave Simulation k=8 *	Lave Supermarket Observation	This Simul'n k=1
Unit Price	30 %	39 %	5 %	29 % (4/14)
P/Q ratio	25	47	35	7 (1/14)
Difference	7	9	22	57 (8/14)
Other / None	38	5	38	7 (1/14)

Sources: Capon and Kuhn (1979, 1982); Lave (1988)

Notes: * Lave's simulations include P/Q ratio problems only. This Table excludes 11 of the 25 subjects that were not asked to attempt Qu.6.

Table 10.7(b) Performance on Interview Qu.6 [Best-buy]: Cross-tabulation of Strategy Used and Answer by Positioning for Part B and Social Class of Parents

Positioning	Middle Class	Working Class/Mixed	Total
PM, familiar with best-buy calculations	14: (6) corr 21: (6) slip 22: (4)/(6) corr 23: (4) c/inc	13: (6) corr 18: (4) c/inc 1: (4) err 3: (4)/(1) ref	corr 3 c/inc 2 err 2 ref 1 strategies (6)/(5) 4 (4) 3 (2)/(1) 1
PM, not familiar	7: (2) ref	17: (4)/(2) ges 2: (4) c/inc 6: (4) c/inc	corr 1 c/inc 2 ges 2 ref 1 strategies (6)/(5) 1 (4) 2 (2)/(1) 3
SM	4: (5) corr 9: (4)/(2) err/ges		
Total Answers	corr: 3 of 7 c/inc 1 slip: 1 ges: 1 ref: 1	corr: 1 of 7 c/inc 3 err: 1 ges: 1 ref: 1	4 of 14 4 2 2 2
Strategies (6)/(5):	4	1	5 of 14
(4) pure:	1	4	5
(2)/(1):	2	2	4

NOTE: Interview / Subject number shown first
Strategy n shown thus: (n)
Answer shown as: corr = correct;
c/inc = correct but incomplete; err = error;
ges = guess; ref = refusing the terms of the question.
This Table excludes 11 of the 25 subjects who were not asked to attempt Qu.6.

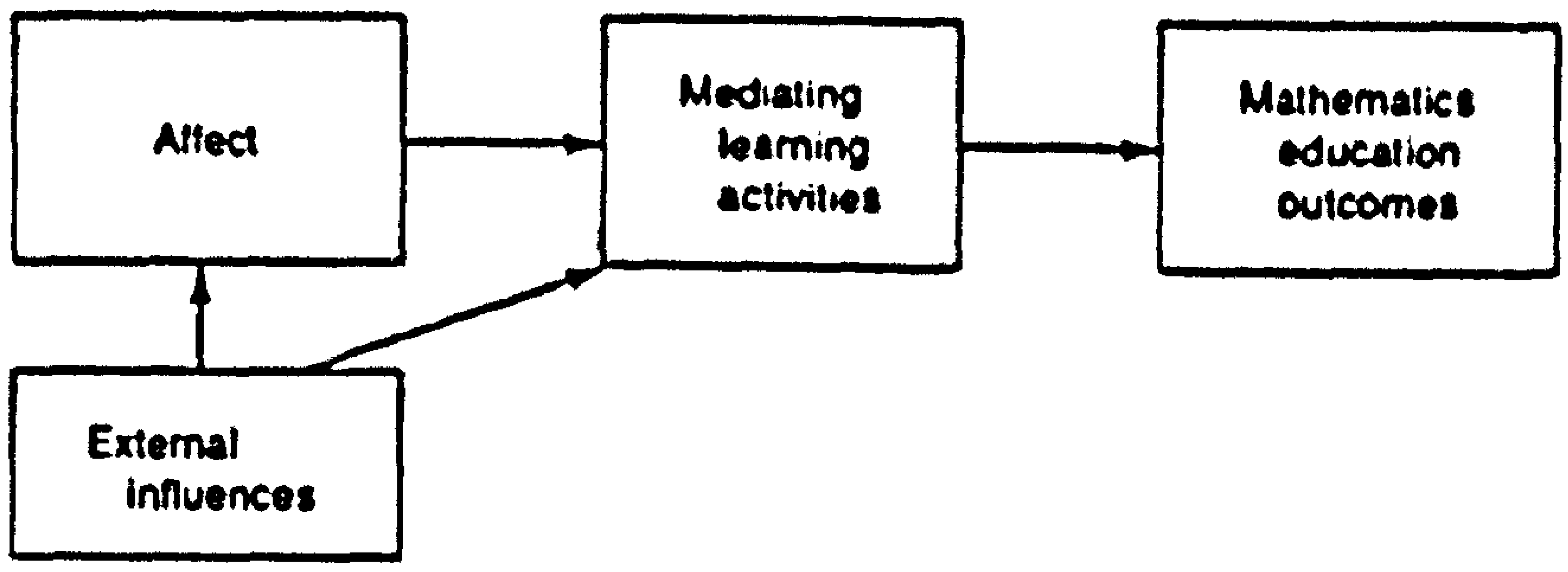
Table 10.8 Expressing and Exhibiting anxiety in the interview: Cross-tabulation of Numbers with Gender (n = 25)

Category	Males	Females
EXP+ and EXH+	6	11
EXP+ and EXH- (?)	3 (nos.8, 10, 18)	2 (nos.6, 24)
EXP- (?) and EXH+	2 (nos.7, 11)	-
EXP- and EXH- (?)	1 (no.17)	-
Total	12	13
Percentage EXP+	75% to 92%	100%
Percentage EXH+	67% to 100%	85% to 100%

Note: (?) = coding not certain
EXP+ = at least one case of the subject's expressing anxiety
EXH+ = at least one case of the subject's exhibiting anxiety
EXP- = no instance of expressing anxiety
EXH- = no instance of exhibiting anxiety

FIGURES

Fig. 2.1 A Generic Model for Relating Affect and Outcome



Source: Fennema (1989, p.217)

Fig. 4.1 Working Conceptual Map for the Polytechnic Survey

```
MATHS COURSES TAKEN
      \
Qualifications in Maths


                          CONFIDENCE
                           /      \
                      Self-rating Expectations
                        in Maths      for Poly

GENDER
                                            ANXIETY
                                           /       \
                                      Numerical      Maths Test/
                                                       Course

                     DIFFICULTY
                     /     /     \
              Everyday   Work    School
                                  Maths              PERFORMANCE
                                                    /           \
AGE                                          Practical          School
                                               Maths             Maths

                         USEFULNESS
                          /      \
                      Everyday  Work


                             INTEREST
SOCIAL CLASS
   \            \
Parental        Student's
Occupation      Own
                Occupation
```

Fig. 5.1(a) Comparison of the Format of Qu.10 on the National Survey and Qu.6 on the Polytechnic Survey

Question 10

CARD 10

25% OFF

ALL MARKED PRICES

If you saw this sign in a shop, would you expect to pay:

a half, or
three-quarters, or
a quarter, or
a third
of the original price?

6\. 25% OFF
ALL MARKED PRICES

If you saw this sign in a shop, would expect to pay:
(a) a half, or
(b) three quarters, or
(c) a quarter, or
(d) a third
of the original price?

ANSWER ....

Fig. 5.1(b) Comparison of the Format of Qu.3 on the National Survey and Qu.18 on the Polytechnic Survey

Question 3

CARD 3

This is a restaurant bill. If you wanted to leave a 10% tip, how much would the tip be?

Soup	.35p
Main course	£2.20p
Sweet	.68p
Coffee	.30p
Total	£3.53p

18\. Suppose you go to a restaurant and the bill comes to a total of £3.72p. If you wanted to leave a 10% tip, how much would the tip be?

ANSWER ....

Fig. 5.2(a) Gender Differences in School Maths Performance (PERFS - 10 items): Boxplots* for Whole Sample

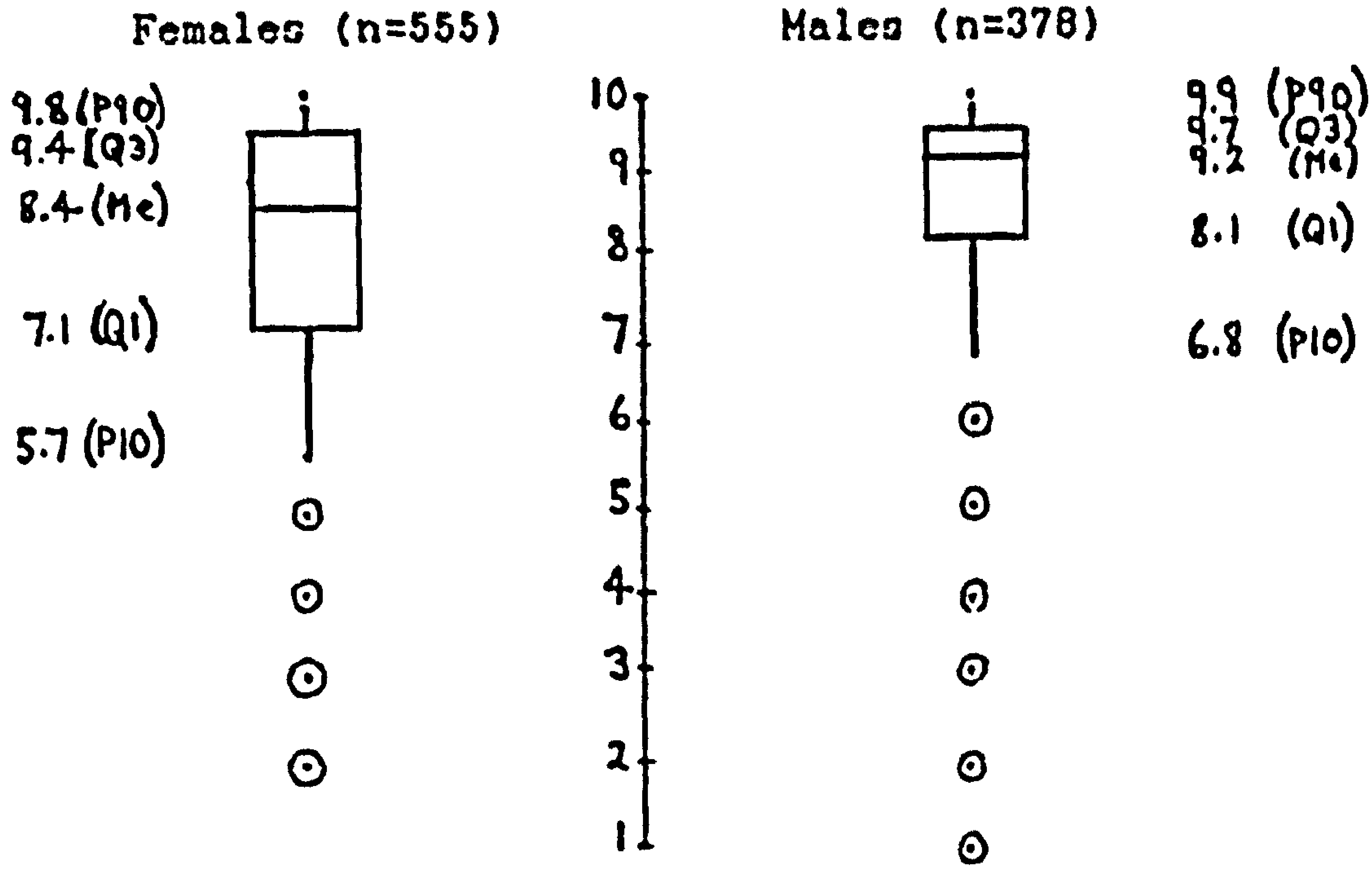
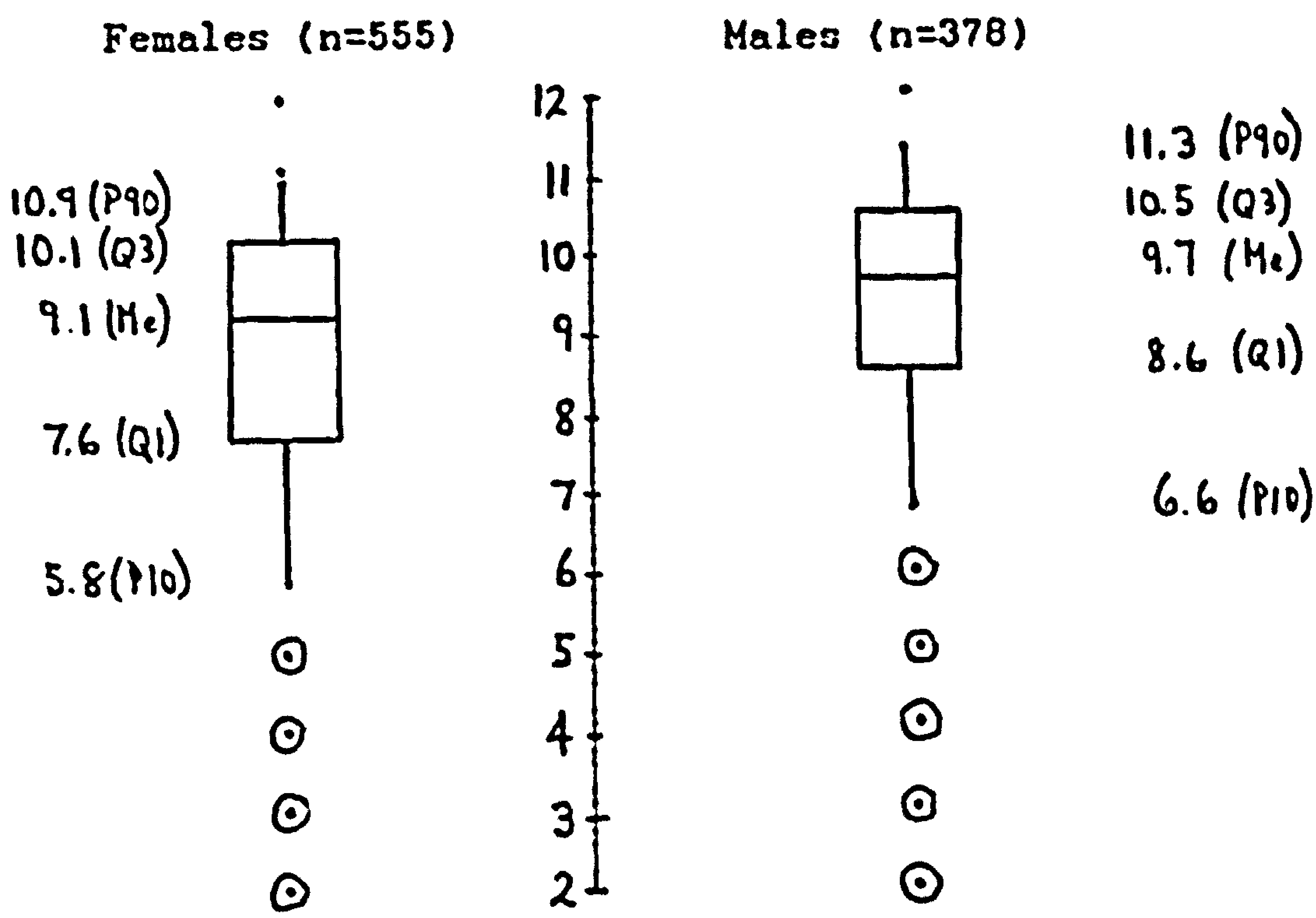
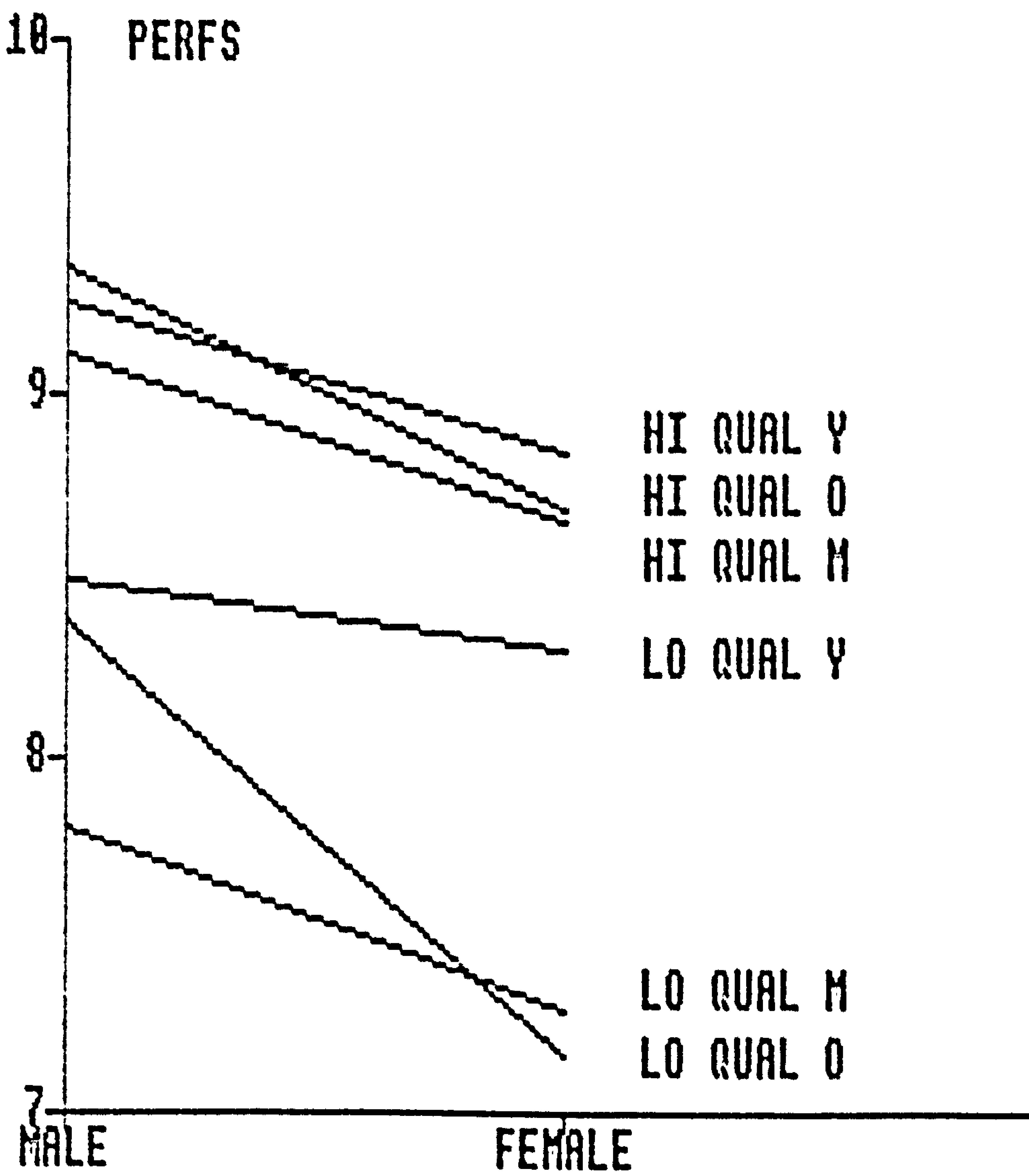


Fig. 5.2(b) Gender Differences in Practical Maths Performance (PERFP - 12 items): Boxplots* for Whole Sample



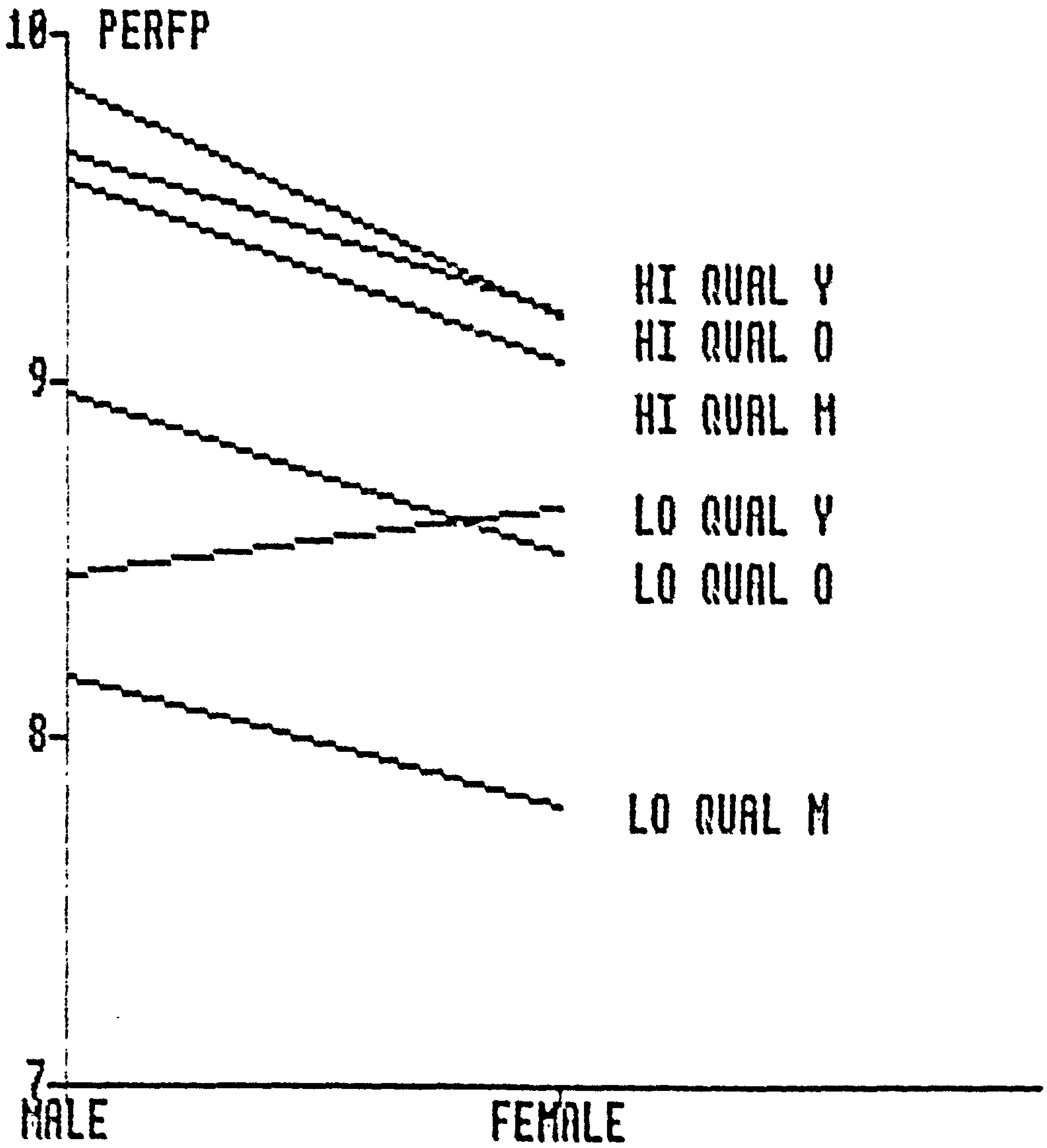
Note*: The median is shown as a line drawn through each box. The quartiles (25th percentiles) are shown as ends of boxes. 10th percentiles are shown at the ends of the solid lines. Extreme values are shown as dots in circles.

Fig. 5.3(a) Differences in School Maths Performance (PERFS) by Sex, Age, and Qualification in Maths: Plots of Means of Subgroups for Whole Sample (n=863)



Note: For Age, Y = 18-20 years old; M = 21-24; O = 25+.
For Qualification, Hi Qual = O- or A-level Maths;
Lo Qual = Other.

Fig. 5.3(b) Differences in Practical Maths Performance (PERFP) by Sex, Age, and Qualification in Maths: Plots of Means of Subgroups for Whole Sample (n=863)



Note: For Age, Y = 18-20 years old; M = 21-24; O = 25+.
For Qualification, Hi Qual = O- or A-level Maths;
Lo Qual = Other.

Fig. 5.4(a) Relationship between School Maths Performance (PERFS) and Maths Test Anxiety (TA): Plots of Average PERFS Score for each Decile of TA for Whole Sample

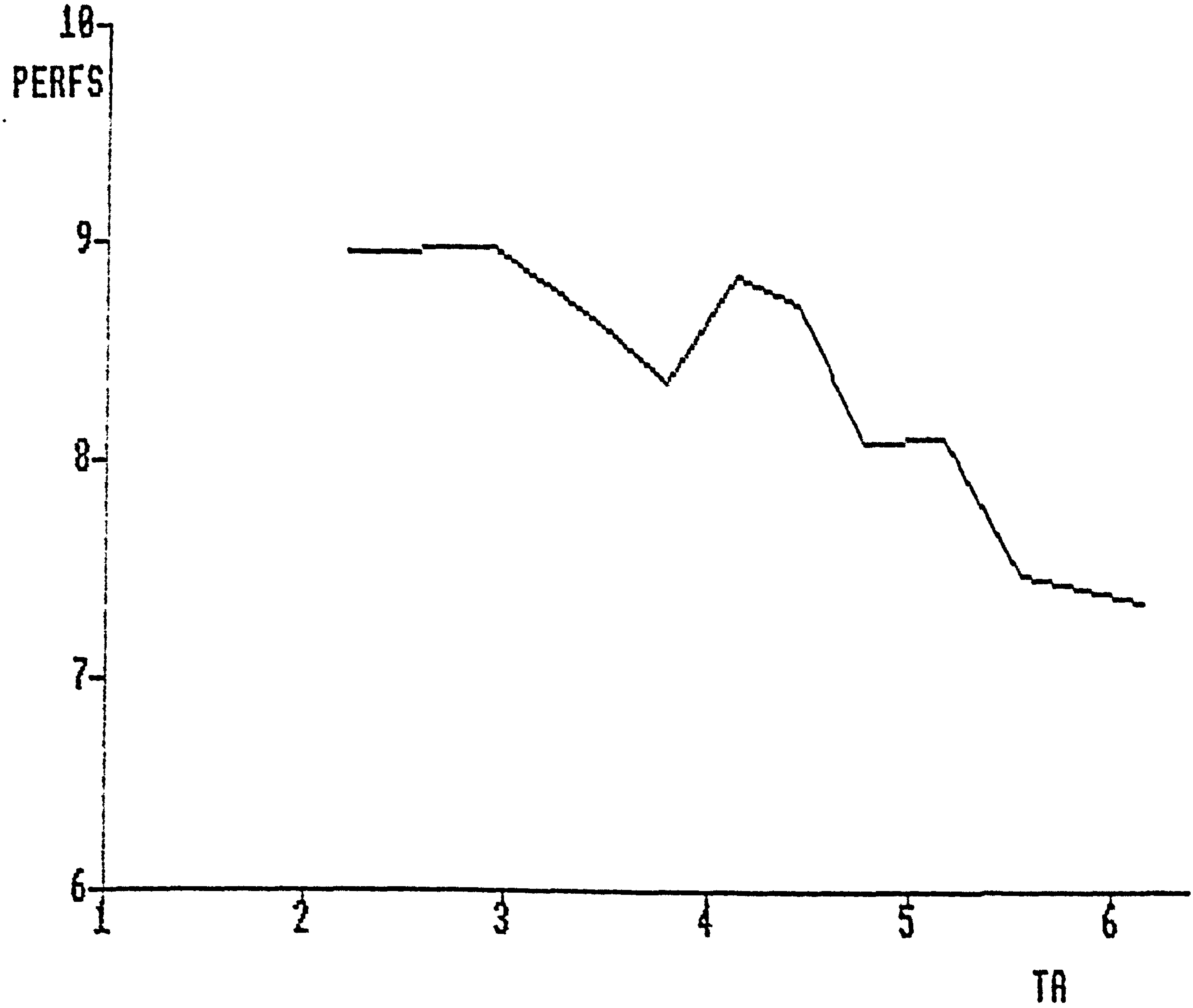
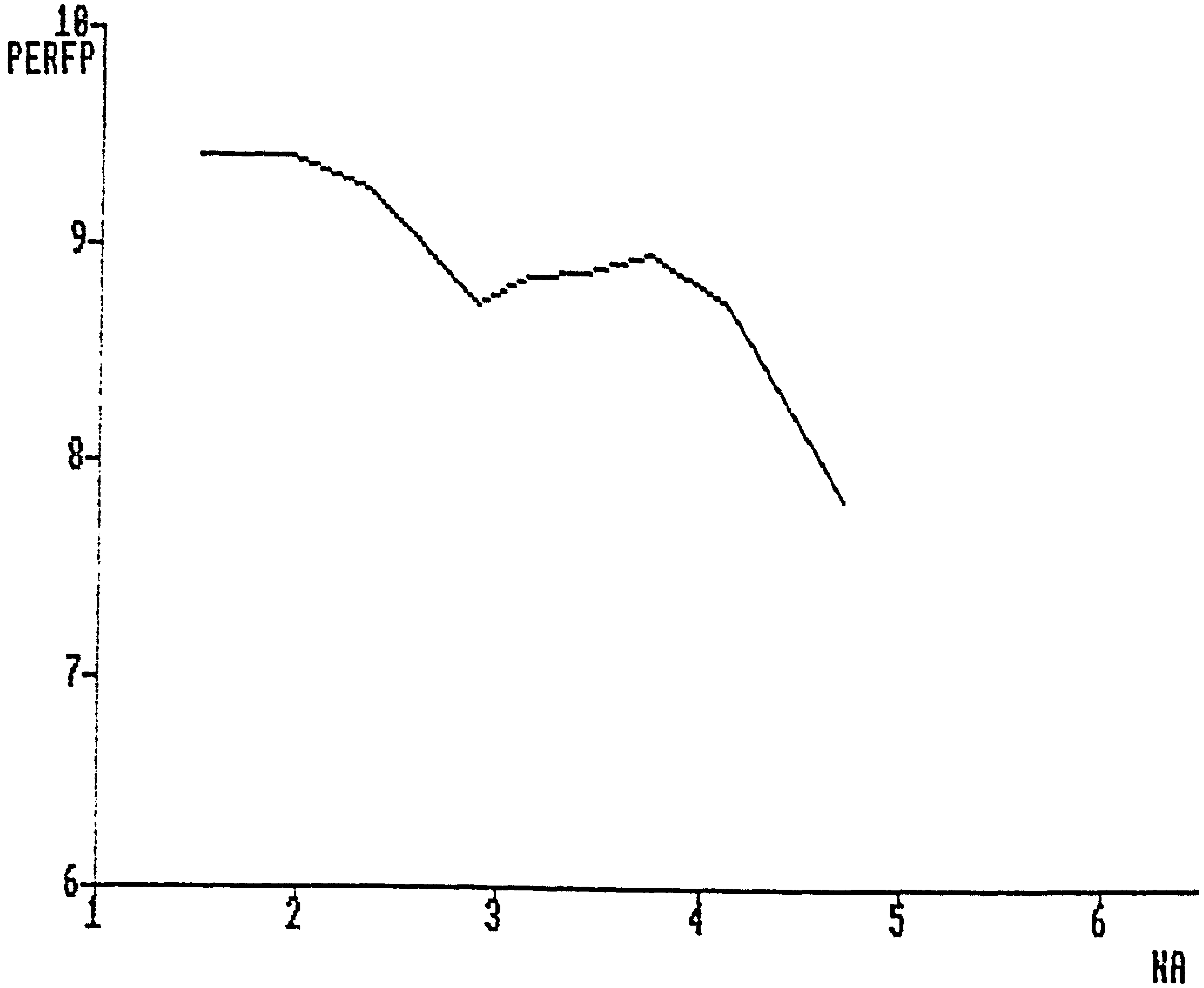


Fig. 5.4(b) Relationship between Practical Maths Performance (PERFP) and Numerical Anxiety (NA): Plots of Average PERFP Score for each Decile of NA for Whole Sample



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NOTES - Chapter 1

1. Though this requirement appears reasonable, it can lead to ambiguities and apparent contradictions, such as the devaluation of the correct performance of certain pupils; see Ch.2.

2. The Maths in Work Project, directed by Mary Harris, was based at the Inner London Education Authority from 1981, and at the University of London Instititute of Education from 1987.

3. Statistics has been seen as a fruitful area for the application of mathematical ideas and skills. Thus, statistics education also developed during this period, beginning with a series of projects and a new journal Teaching Statistics based at Sheffield University, and the first International Conference on Teaching Statistics in 1982.

NOTES - Chapter 2

1. The parallels and links between literacy and numeracy merit further study, but they cannot be discussed further here; see e.g. Levine (1982) and Hamilton and Stasinopoulos (1987) and the references therein.

2. Ethnic group differences are not considered here, for several reasons. The literature on this issue was only just beginning to appear (even in the USA) when I began work on this thesis. In addition, in the UK, the difficulties of measuring ethnic background were well-known: the validity of parental birthplace as an indicator was declining as time passed, and there was resistance - which threatens response rates - to alternative questions among respondents in the run-up to the 1981 Census. This judgement seemed to be vindicated in the questionnaire fieldwork, when there were refusals to answer questions on parental occupation and, apparently, gender.

3. Cline-Cohen (1982), in her history of the spread of numeracy in the English-speaking countries, cautions against using a strict threshold in defining numeracy, either for an individual or for a society, and suggests that "the most interesting question is not how crude numeracy rates have changed over time, but rather how the domain of number has changed and expanded." (p11).

4. I argue later in the thesis, in Ch.11, that familiarity must be seen as having both cognitive and affective aspects.

4a. For a systematic investigation of a set of pedagogic strategies including this approach, see Straesser et al. (1989, sec. 2.2).

5. The APU written test data allow researchers to examine such "effects" of the context - i.e. the situation described

in the problem. For example, at age 11, several items involving what can be seen as the relationships 2/3 = x/12 and 3/8 = x/24 were devised using different contexts; see Foxman et al. (1985, pp. 151-2).

6. Sampling took place at 200 sampling points in 10 regions in England, Wales and Scotland. The interviewers were given quotas for sex by age, social class and employment of respondents.

7. These results are subject to sampling variation (see ACACE, 1982, p.9); thus, any difference between the male and female subgroups of 4% or less would not be very "impressive" (or "statistically significant") - since it would not be greater than the "margin of error", and therefore could be expected to occur, due only to chance, 19 times out of 20.

8. Also, the higher the terminal education age - which can be considered another indicator for social class - the better the level of performance; see ACACE (1982, p.25).

9. From this point onwards, all of the Tables and most of the Figures will be placed at the back of the thesis, rather than in the text.

10. The 1990 survey was based on a sample (type unspecified) of 1034 adults aged between 21 and 60 in England, Wales and Scotland.

11. The disagreement among researchers about "when boys started to pull ahead" was based on the 1978-82 surveys of the APU and the 1974 Schools Council survey (Ward, 1979). The details are not relevant here, but see e.g. Shuard (1982, 1986) and Walden and Walkerdine (1982, 1985).

12. In the UK, the proportion of first degrees in mathematics obtained by women in 1983 was 29%, and for doctorates the figure was 9%; the corresponding figures for English were 67% and 35% (Royal Society and Institute of Mathematics and its Applications, 1986, pp.12-13). In the USA, the corresponding figures for maths in 1977 were 41.5% of 1st degrees and 13.3% of doctorates (Chipman and Thomas, 1985, pp.15-20). See also Cohen and Fraser (1991) who report that, in the UK, the figure for first degrees in mathematics and statistics was 34% in 1985-87 (derived from their Table 7; this figure excludes data on universities in Wales and N. Ireland.)

13. Recent data are given for Canada in Muller (1987).

14. Nevertheless, Fennema (1979) argued that there were no gender differences in general intelligence, and none in verbal areas related to the learning of mathematics. However, a relationship between spatial visualisation abilities and performance in mathematics at school might be expected. Yet empirical results in the late 1970s and early 1980s were not consistent. Armstrong (1980) included a spatial visualisation component in her national survey measures: she found no difference in Grade 12 (age 17 or 18)

and a statistically significant difference, in favour of girls, at age 13. Connor and Sabin (1985), in a review of various dimensions of "visual-spatial skill", and various tests, found that:

- differences favouring males were found only on some tests, and in some settings;
- only two of the four skills examined, "spatial orientation" and "visualisation" seemed to predict maths achievement, and this relationship was stronger for males than for females - suggesting perhaps gender differences in approaches to problems; and
- these skills can be improved with brief training sessions.

Thus there seemed to be little if any basis for seeking an explanation for gender differences in maths performance on the basis of "abilities" such as spatial visualisation.

15. As part of his meta-analysis, White found an average correlation of .20 between SES and scores on standardised scores of mathematical attainment in 128 studies where the individual student was the unit of analysis. Though it is difficult to compare this with the sizes of gender differences reported in the previous subsection, it is rather low.

15a. This study shows about 25% of the variance in results of 17-year-olds accounted for by eight "background" variables, and this is reduced only to 15%, if one excludes those indicators which are based on aggregated units of measurement, such as "percent of professionals living in the community", and uses only those based on the individual - namely, "parent education" (mean level of schooling) and "extent of reading material in the home". The figure of 15% is based on my re-analysis of the data in Table 1, p.149.

16. This is because it is assumed that children continue to develop to the end of secondary school, and because most studies focus on children in one or two school grades, or say 11 and 15 year olds, and age differences within these groups are usually ignored. An example of a study that does consider age-within-grade differences is Clements and Wattanawaha (1977).

17. Despite these reservations, the review of the social variables in sec. 2.3.1 remains useful for sensitising me to issues that might arise in the interviews. Also, the divisions between the individual and the social, and between the cognitive and the affective, which are implicit in most of the theories discussed in this and the next chapter, may need to be rethought; see the second half of the thesis.

NOTES - Chapter 3

1. A 3-point scale had been used with 11-year-olds until 1982. The change led to fewer "unsure" (the middle point) responses.

2. A more detailed consideration of affect is proposed by the "academic choice" model (Parsons et al., 1983). This

model uses an "expectancy-value" approach, so called because the "perception of task value" and "expectancies of success" are seen as operating together to produce the probability of choosing to do another maths course (or that of other achievement behaviours). Chipman and Wilson argue that this approach allows us to subsume most of the "affective" factors previously discussed under "expectancy" (confidence, perceived difficulty, causal attributions) or under "value" (enjoyment, perceived usefulness of mathematics) (1985, pp.294-95).

3. There is another kind of support for links between confidence and anxiety, in addition to these empirical findings. Theoretically, a relationship between confidence ("feeling able to change to move towards a goal state") and anxiety ("feeling unable to change to move away from an anti-goal state") is suggested by Skemp's (1979) "cybernetic" discussion of action directed towards goals.

4. These two forms might now be distinguished basically as "anxiety neurosis" and "anxiety hysteria" (Laplanche and Pontalis, 1973, pp.37-40).

5. The distinction here between worry and emotionality is reflected in distinctions in other work; e.g. that between "attitude" and "emotion" in McLeod (1988); see Sec. 3.1.

6. One of the pioneers of physiological psychology W.B.Cannon, in an article called "'Voodoo' death" (1942) reported on the results of a broad anthropological survey from which he concluded that , in a wide range of cultures, it was possible for a man to die of fright, if for example he was condemned and sentenced by a "medicine man".

7. The Yerkes-Dodson Law can be seen to be related to the "Hullian equation" in the behaviourist research programme:

PERFORMANCE = HABIT STRENGTH X DRIVE, where

PERFORMANCE = the probability of producing a particular response, and
DRIVE = the extent of energisation or activation of the organism (a measure of motivation).

7a. This was so even when they allowed for task complexity, or when they distinguished anxiety as a personal characteristic (measured by the MAS) from "threat" (or "stressor") introduced into the experimental situation; see Reed's review (1960, pp. 145-147).

8. The motive to avoid failure was measured in Horner's work using the Debilitating Anxiety scale of Alpert and Haber (1960), and in earlier work, using the Test Anxiety Questionnaire - both indicators of expressed anxiety. On the other hand, both the success or achievement motive, and the motive to avoid success were measured using projective material produced in response to verbal cues. Thus, the "resultant achievement motivation" index, produced by subtracting the standardised anxiety score from the standard score for achievement motivation, was based on a mix of

different types of measure (cf. sec. 3.2.2).

9. Richardson and Suinn's validation of the MARS as a measure of maths anxiety was highly circular - since the change in MARS scores after behaviour therapy was presumably *also* being used to evaluate the therapy itself.

10. It is perhaps not surprising that "maths test anxiety" was the name given by Rounds and Hendel to one of the two factors they produced. They had already built a concern with test anxiety into their study - by using Suinn's test anxiety scale STABS as one of the other scales with which they correlated the results on their two new subscales, in order to explore the validity of the latter.

11. The Fennema - Sherman MA Scale, as part of their battery of scales of attitude to mathematics (see sec. 3.3.1), is scored with a reversed polarity to that used by other MA scales - i.e. less anxiety is scored higher. Thus Betz' paper reports a positive correlation here. However, throughout my discussion of results using the MAS, I shall reverse the direction of correlations reported, in order to maintain a substantive consistency with results reported using the MARS, etc.

11a. Nancy Betz (1977,1978), in a study at a large midwestern universtity (n=652), used revisions of 10 of the 12 items from the Fennema - Sherman MAS, originally developed for secondary school ages. The sample included students from Math 1 (a basic revision course), Math 2 (precalculus) and Psychology 1 (introductory). Her criterion measures were entrance test mathematics and verbal scores; thus, performance and maths anxiety were measured in sessions separated by some time, so that the view of the maths anxiety scale - here, the MAS - as a trait measure is reinforced. Her findings included:

- a high prevalence of maths anxiety, with one-half of Math 1 and one-quarter of Math 2 and Psychology students agreeing that maths made them feel "uncomfortable, nervous, uneasy, and confused" (1978, p.446);
- negative (see NOTE 11 above) correlations (statistically significant) with the entrance test mathematics score for all 3 groups for the whole sample - whereas correlations with the verbal score were close to zero for all 3 groups.

This second finding provides some evidence for the validity of the MAS as a measure of maths anxiety for college-age populations, in the USA at least. However, as with Richardson and Suinn, the methodology used - comparisons of means and zero-order correlations - limits the extent to which other variables which might also affect maths performance can be controlled for.

12a. Hendel's (1980) study involved the 69 female participants in a maths anxiety programme at a large midwestern university. He found correlations of -.68 between MARS and a measure of self-rating of mathematics ability, and -.53 (statistically highly significant) between MARS and a local institutional arithmetic test (based on multiple-choice questions, but untimed). Nevertheless, Hendel noted that Betz (1977) found that mathematics anxiety added relatively little to the prediction of maths performance (after ability etc. had been considered). He himself attempted to deal with the problem of predicting arithmetic test scores from a set of highly intercorrelated predictor variables, by assigning an amount of "R-squared change" to each predictor variable. At first sight, the MARS scores much higher on this criterion than do his other variables: self-rating of mathematics ability, number of semesters of high school maths, facilitating and debilitating anxiety (Alpert and Haber, 1960), fear of negative evaluation, years since formal maths instruction, and test anxiety - though the size of the MARS' zero-order correlation ranks only fourth, behind the first three predictors in the present list. On closer inspection, this apparent power of the MARS variable comes from its being forced to enter first into a stepwise regression procedure! This means that it will "absorb" all the variance which it shares with other predictor variables (because of being correlated with them) in "explaining" the performance variable; thus its "R-squared explained" figure is misleading. Therefore it appears that the Hendel analysis does not provide evidence that the MARS has predictive power of maths performance additional to that associated with "aptitude", number of secondary maths courses, test anxiety, etc.

12. Llabre and Suarez also claim to have refuted the hypothesis suggested by Fennema (1979 - see sec. 2.3.1) and by Tobias (see Sec.8.1), by showing that maths anxiety could not be predicted by the Fennema - Sherman "Maths as a Male Domain" (MD) scale.

13. Also, Betz (1977, 1978) found significantly less anxious male scores for Math 1 (revision) and Psych 1; and slightly less anxious female scores for Math 2 (precalculus, i.e. prior to taking other maths courses).

NOTES - Chapter 4

1. Mandler's distinction between macro and micro approaches is closely related to the distinction made between the experimental and the survey "styles" of research, on the one hand, and the "ethnographic" style, in the Open University course <u>DE304</u>: <u>Research Methods in Education and the Social Sciences</u> (1979); for some discussion on combining the styles of research, see Evans (1979).

2. During the period of the study, many students went on to complete the third year of their degrees on another course at this or another Polytechnic. This largely ceased when the DipHE became the Modular Degree Scheme in 1985-86.

3. Another advantage for the research was that the first year courses in Maths / Quantitative Methods were taught in a way that the students generally acknowledged as humane. Hence there was less risk, I hoped, that my request for interviews would meet with flat refusals, as had happened in Brigid Sewell's (1981) research, for example; see Sec. 7.2.

On (i), the IPA / JICNARS "ABCDE" scale aims to reflect social grading: unlike the R.G., it uses not only occupation, but may also use the style of residence and self-presentation of the respondent (Duriez et al., 1988, pp.33-39). Social status is considered to be able to be appreciated "quasi-intuitively, quasi-directly" (p. 39). One difference is that younger people tend to be classified lower by the IPA: this tends to mean that the R.G. scale produces a "higher" class composition on student's own occupation for the Polytechnic sample than the IPA would do. On (ii), market researchers would tend to use the parents' (usually father's or head of household's) occupation, especially if the student were living at home, and the student's own occupation for those who had already had a full-time job.

4. The survey methods litererature does not provide much additional help on what differences to expect between an administered and a self-completion performance survey. See Moser and Kalton (1971) and Hoinville and Jowell (1978) on the effects of question wording and ordering, for "administered" and self-completion questionnaires generally.

5. This is the sort of issue which would need to be explored in an interview situation, where it would be possible to explore what activity was recalled or "called up" in response to such a question; see Chs. 9, 10, and 11.

6. The A.P.U.'s work on mathematics testing (see sec. 2.2.3) has also done much investigation of the influence of question format on responses (see e.g. Foxman et al., 1985), but in a different way to that used later in this thesis; see Chs. 7 - 11.

7. The performances on the two questions on reading the graph showing temperature changes over the course of a day are worth comparing across the two surveys. They were done rather well by the students - 93% and 87% correct respectively - compared with the national survey results of 87% and 72% correct respectively. This suggests that, though there was little difference between the students' facility at reading the abscissa and the ordinate in a graph, there was a greater difference for members of the public. If this difference were to be replicated in other studies, it might have implications for the presentation of graphs for public consumption.

8. The level of non-response, which had never been more that 3% for any question up to that point in the questionnaire, reached 15% for Qu.16, and was never below 6% or 7% from that point on. Apparently, the time limit was beginning to take its toll by this point.

9. Since estimates of reliability were not produced for the scales used in this study, all correlations reported must be considered as upper bounds.

10. For discussion of the "trait" and "state" anxiety, see sec. 3.2.1.

10a. From the summary statistics given in Table 5.6, it appears that the age distributions of males and females in the whole sample were substantially the same. However, for specific samples, the percentage of "mature" students (those aged 21+) varied widely; for example, for the BASS 1985 entry (B85), it was 55% for females and only 40% for males, as compared with 64% for the whole sample. Since it was expected that the under 21s would perform better on PERFS and PERFP than the 21+ group (see sec.4.1.3), it was clearly important to consider the gender differences in performance while controlling for age.

11. In checking for "interaction" effects, one would ideally begin with two-way interactions - by inspecting the table (or graph) of means for subgroups formed by taking two factors at a time. However, a discussion of this procedure is omitted for reasons of space.

11a. I also considered "standardising" the mean scores for the two gender groups to allow for their differing distributions of qualification and age. However, this strategy is not suitable when there are interaction effects (e.g Kalton, 1968) - as there seem likely to be both for PERFS and for PERFP.

12. The categories originally used were: non-manual full-time (NM), non-manual part-time or temporary (NMT), manual full-time (MAN), and manual part-time or temporary (MANT). However, the NMT and MANT categories had been coded to include students who had worked <u>either</u> part-time <u>or</u> temporarily in non-manual or manual occupations, and I was reluctant to aggregate either of these statuses, especially the temporary occupations, with full-time workers for the purposes of studying correlations of last occupation with outcome variables. And, though I did consider attempting to separate part-time work from temporary jobs, it was not always possible to do this on the basis of questionnaire responses.

13. During the subsequent statistical modelling, it was found that the second method of aggregating SCF and SCM produced better predictions of the performance variables; it was therefore used in Ch.6.

14. Further examination of the data relevant to this issue suggested that the subgroup that "pulled down" the average of the "mixed" group on all these variables was the group of 13 students with father's occupation manual and mother's professional or managerial (R.G. I or II). However, the numbers were admittedly very small. And the fact that 12 of these students (92%, compared with 59% of the whole sample) were women suggests that this may have been a very special group - as well as possibly an interesting focus for future research.

15. I had intended to re-examine these differences in performance and affect with parental occupation held constant; however, the numbers in each category of SCP by SCS were too small (as few as 10 in one case).

16. For a sample size of 935, the critical values of the correlation coefficient, r, are approximately 0.065 for 5% statistical significance, and 0.085 for 1% statistical significance. For a sample size of 619, as would be appropriate for analyses based on the 1984 and 1985 samples only - such as those involving USED and USWK, the corresponding values of the correlation coefficient, r, would be approximately 0.08 for 5% statistical significance, and 0.103 for 1% statistical significance.

17. Thus, each graph was based on ten points: each ordered pair was formed by the midpoint of the corresponding decile of the distribution of the relevant maths anxiety variable and the average performance score for this decile group (relating to 90 to 95 students). For example, the first three points on the graph relating PERFS to TA in Figure 5.4(a) were: (2.2, 8.95); (2.93, 8.97); (3.42, 8.65). This method was chosen when it became clear that the scatterplots produced by the statistical package used for the analysis would not be sufficiently informative, because of the difficulty of interpreting the indications of multiple frequencies of many of the observed points.

NOTES - Chapter 6

1. The factor analysis programs used here nevertheless employed the "exploratory", rather than the "confirmatory", approach; on the differences, see McDonald (1985, esp. Chs. 3 and 6).

2. In order to check that the number of factors was not inflated by picking up on demographic differences such as gender and age, the number of eigenvalues greater than 1 was checked for two different four-way breakdowns: gender and qualification in maths (O- or A-level pass vs. the rest), and gender and age (18-20 vs. 21+). For each of the subsamples split on gender and qualification, 5 factors were found, except for the High-qualified Female subsample (3 factors). For each of the subsamples split on gender and age, 4 factors were found, except for the Young Male subsample (5 factors). That is, at least as many factors were produced from analysing the subsamples, as from the whole sample. From this I concluded that the number of factors specified for the whole sample was not inflated by qualification in maths, gender, or age differences.

3. In regression models, neither outcome variables nor predictors are "latent" or unobserved, as are the factor scores in factor analysis.

4. This "holding constant" of all the other predictor variables is of course done in a statistical way, rather than by using the sort of "physical control" used in experiments.

5. Despite reservations about Rounds and Hendel's division of items into numerical anxiety and maths test anxiety, their division formed the initial basis for the dimensions

of maths test anxiety, TA, and numerical anxiety, NA, used in the regression modelling in this chapter - since their analysis had been subjected to scrutiny and attempted replication in the literature. However, both the models for TA and NA, and the models for performance run with the two anxiety factors as potential predictor variables, were checked for stability of results when N10, N24 and N30, the three "maverick" numerical anxiety items, were included in TA, rather than in NA; this change did not lead to any appreciable differences in the values of the regression coefficients, nor in R-squared, which seemed to necessitate presenting both of the two alternatives for comparison. Further, it was decided not to run the performance models using three dimensions of maths anxiety, as this would have cut across the meaningful links between PERFS (school maths performance) and TA, on the one hand, and PERFP (practical maths performance) and NA, on the other.

6. It will be recalled that Sec. 5.6 discussed two indices of parental social class, which differed only on the allocation of the students whose father's occupation was classed as manual, and whose mother's occupation was III NM (clerical, etc.) - about 5% of the 1985 sample. In this chapter, the index which allocated such students to Working Class parentage (rather than to Mixed parentage) is used, since it proved to be a more powerful predictor in the early analyses.

7. The comparable confidence intervals for the <u>whole sample</u> are .26 to .54 of a scale-point for TA, and .02 to .26 of a scale-point for NA. Note that here the gender difference for NA remains on the borderline of statistical significance.

7a. A 95% confidence interval estimate for a difference of interest can always be produced, given the value of the point estimate for the value of the difference, and the value of the standard error of this estimate; it is the interval from {point estimate - 2 Std. Errors} to {point estimate + 2 Std. Errors}. (The figure 2 (1.96) comes from the tables of the Normal distribution.) For this reason, confidence intervals will be presented in the text only for the most discussed estimates.

8. In order to make comparisons with the results for maths test anxiety (TA), the most important affective variable, confidence of self-rating in school maths topics (CONFSR), was modelled in the same way. It was expected that the results would be similar, since CONFSR and TA were highly correlated (r = -.58) in the whole sample. This was largely borne out; that is, there were advantages in CONFSR for students who were qualified in maths, male, and younger (18-20). However, there were two differences between the model for the two variables. First, the models for CONFSR had somewhat more predictive power than those for TA. Second, in the model for the whole sample, because of a qualification by age interaction, the age difference in favour of younger students held <u>only</u> for students without qualifications: that is, there was no "disadvantage" in terms of confidence to being older (21+), if a student had O- or A-level maths.

9. The argument might be put that QUAL (qualification in maths) should not be entered as a predictor in performance models, because it was subject to the same influences as performance, and therefore should also be considered as an outcome. While I would argue in response that doing a GCE A- or O-level maths course successfully represents an additional input from the school, and probably also from the student (in effort, etc.), it was decided to re-run all the performance models with QUAL and the related interactions entered last. This did not make an appreciable difference to the other coefficients in the model.

10. These figures were calculated from data on which Fig. 5.3(a) was based, but not presented in the thesis.

11. The variable SEX was coded 1 for women and 0 for men; AGE2 was 0 for younger (18-20) and 1 for mature students. The dummy variables for interactions were generally formed simply by multiplying together the dummy variables for the main effects; for example, given these codings, the SEXxAGE2 term was coded 1 for older women and 0 otherwise. Thus, the estimate of the gender difference for younger students, here (younger women - younger men), is given by the SEX coefficient in the the regression equation - namely, - 0.16. The estimate of the gender difference for mature students, (mature women - mature men), can be represented as the sum of the estimates of the SEX and the SEXxAGE2 effects. The estimates for the standard errors of each effect are either given by the computer package, or calculated from results given by it.

12. A gender by qualification in maths interaction had been expected for both of these models, because of the likelihood that A- and O-level qualifications are (produced socially as) more demanding hurdles for females than for males; in that case the effect on the outcome variable (e.g. PERFS) of having gained a particular qualification should be greater for females than for males.

12a. When the "top-down" check was made on interactions of order three or above, it was found that the QUAL by SEX by AGE2 interaction was highly significant. However, it was not retained in the model because its entry inflated the standard errors for the QUAL, SEX and AGE effects, to an extent judged to be excessive.

13a. It is interesting to note that the qualification in maths differences had been larger before CONFSR was brought into the model. This is understandable, given that CONFSR was highly correlated with and undoubtedly influenced by qualification in school maths (see APPENDIX R9). This suggests that a student's confidence (self-rating) in maths might have been influenced by their earlier success in school maths, even if their schooling took place many years ago.

13. There are several reasons why the value of R-squared for the model for the 1985 sample might be as much as 10% more than that for the model for PERFS using the whole sample.

One is that the inclusion of the social class variables was reckoned to add 4% or 5% to the value of R-squared. Another might be that, since the 1985 sample was of course more homogeneous than the whole sample (which included 1983, 1984 and 1985 entrants), the correlations of the performance variables with the predictors should have been higher for 1985 than for the whole sample. This was borne out by a comparison of the correlations of PERFS with qualification in maths, maths test anxiety and confidence, for the two samples.

14. The 2x2x2 gender / age / qualification breakdown for the 1985 data (not presented here) confirmed the whole sample result for mature low-qualified women.

15. The measures of difficulty in using numbers in work (DFWK), use of numbers in work (USWK), and use of numbers in every day life (USED) were not tested for inclusion, because they were available only for 1984 and 1985.

16. It will be recalled that the same question was posed about the possibility of performance items "having no context" in connection with Rees and Barr's work; see Sec. 2.1.

16a. This claim is given further support by interchanges in interviews nos. 11 and 16 (Harriet); see the full discussion of the latter in sec. 11.3.4.

17. The question used for SCS asked for the student's "most recent paid work", but this work may not have lasted very long, nor have been very instructive, in the case of the younger respondents - and for older students, especially women returning to the job market after having brought up children, it may not have been a very good indicator of their total work experience.

18. Of course, this conclusion depends on the range of seven responses available for each anxiety item:
1 = "very relaxed"; 2 = "relaxed"; 3 = "fairly relaxed";
4 = "neither relaxed nor anxious"; 5 = "a little anxious";
6 = "moderately anxious"; 7 = "very anxious".
This study was unlike that of Rounds and Hendel (1980) and most of the other US research, in offering a "symmetric" scale of seven responses for each anxiety item including the three degrees of "relaxed" responses (rather than simply a range of "anxious" responses). Without this 7-point scale, it is possible that the quadratic relationship I found would not have been noticeable: for example, the value of PERFS in the model was greatest between TA = 3 and 4, i.e. between an average response of "fairly relaxed" and one of "neither relaxed nor anxious". The assumption was also that "more relaxed" could be taken to mean the same as "less anxious". The meaning and validity of this set and other possible sets of anxiety item responses needs further study.

NOTES - Interlude

1. It is also possible to criticise the validity of the

indicators for performance, on the basis of the selection of items; for example, it might be argued that items to do with spatial or geometrical thinking are under-represented in PERFP and PERFS.

2. One way of "saving" the cogency of a unidirectional causality (from anxiety to performance) would be to see maths anxiety as trait - and the performance measure as an indicator for something much more transitory. Such caution might often be appropriate, especially for performance measures with relatively little validation, such as those used here. However, many of the other studies published in this area have used performance measures such as entry tests and course grades which presumably are considered to be relatively stable indicators of "ability" or "attainment"; see Sec. 3.3.

3. In order to sort out the direction of causality, one solution would be to administer the maths anxiety scales before <u>and</u> after the completion of the performance scale - but conditions did not allow this here.

NOTES - Chapter 7

1. Asking people to keep diaries of the mathematics they use over a specified time (see e.g. Sewell, 1981, pp.3-4) might be considered a form of interview. A hybrid method might involve doing a "task analysis" of a job description; for some indications as to how this might be done, see the discussion of methods of specifying the skills needed in certain occupations, and of assessing their development in Youth Training Scheme trainees in Wolf (1984) and Wolf et al.(1989).

2. The sampling method might be called "multiple snowball recruitment" with the snowballs starting from the enquiry officer's friends, colleagues, adult numeracy classes, WEA class, and an Open University introductory course (for the Arts Foundation Course). For the first interview, 107 respondents were recruited. In Sewell's second interview, a smaller number of respondents (n=50), considered to have interesting patterns of experiences with and perceptions of maths, were selected from three bands of competency - depending on facility with percentages - produced at the first interview. The representativeness of the sample was acknowledged as a problem (Sewell, pp. 10-11) It could be assessed further by comparing its breakdown on age, number of years of initial education and occupational class, with the breakdown of the national population of adults. Further its responses on the competency questions in the second interview could be compared with those from the Gallup national sample, which used two or three questions very similar to several in Sewell's second interview; however, there would be difficulties of comparison because of the different contexts of the responses in the two interviews (cf. Sec.5.2) and because of the slightly more complex (i.e. more "practical") formulations for the questions used by Sewell.

3. The number reporting difficulty with the use of numbers in everyday situations can be compared with the number of respondents in the ALBSU / NCDS study reporting problems with "since leaving school ... number work or basic maths" - also 5%; see sec. 2.2.2.

4. A survey of the <u>statistical</u> skills needs of adults in work was done by Holmes (1985).

5. Cobb (1986) attempts to draw an analogy between ethnomathematics and childrens' self-generated maths (SGM). However, as Cobb himself points out, SGM is "essentially individualistic" (1986, p.7), whereas it is clear from D'Ambrosio's account that ethnomathematics is intended to refer to the practice of "identifiable cultural groups": that is, it is particularistic - but not individualistic. Cobb also points to the importance of socialisation, or social relations, in producing or avoiding difficulties in learning school maths. First, an early goal of academic maths (AM) instruction is to "replace children's self-generated counting arithmetic with academic,

set-theoretical arithmetic" (1986, p.7). The criterion of acceptance for the AM methods that replace the child's SGM methods is not only (i) that they work, but also (ii) that "concepts and procedures must be expressed in terms of conventional symbol systems"(p.7). This can lead to difficulty when the child begins SM at school:

> Unless the child intuitively realises that standard formalisms are an agreed-upon means of expressing and communicating mathematical thought, they can only be construed as arbitrary dictates of an authority.... The child's overall goal might then become to satisfy the demands of the authority rather than to learn AM per se. This goal can be achieved, at least in the short term, either by covertly constructing and using self-generated methods, or by attempting to memorize superficial aspects of formal, codified procedures. If the latter approach is adopted, mathematics becomes an activity in which one applies superficial, instrumental rules. (Cobb, 1986, p.7)

The second related source of difficulty indicated by Cobb is the nature of the interaction between teacher and student: it is crucial how the teacher uses the power imbalance that necessarily exists in the teaching situation. The teacher's expectations may be construed as demands, and the students' primary goal might well become finding any means as all of satisfying them. If this occurs, we can see that the students' overall goal has become that of solving problems that derive from social interactions (1986, p. 8) - rather than learning the mathematics.

6. This conclusion is not warranted by Table 8, which is therefore misinterpreted in the text of the article (CCS, 1987, p.89). However, Table 6 suggests that the conclusion <u>might</u> be sound - though as the authors themselves imply, the numbers are too small in several cells to allow dependable conclusions.

7. See the discussion of case studies and illustrations in Chs. 10 and 11; for example, Peter uses what can be recognised as school algorithms, but is reluctant to write them down - in the interview situation, at least.

8. Two incidents from the cooking club are discussed in Sec. 8.1.

9. In a report of research aimed at changing student-teachers' beliefs about teaching and mathematics, Kathryn Crawford (1992) distinguishes between activities / actions and operations on the somewhat different basis that the former are conscious, purposeful and available for review, while the latter are usually unconscious and automated.

9a. In her conception of activity, Lave seems to have played down the explicit links with Soviet psychologists such as Vygotsky which featured in an earlier report of the Adult Math Project research (Lave et al., 1984).

10. From this point onwards, the term "practice" will be used interchangeably with "activity" (in Scribner's sense), unless indicated otherwise. This is especially helpful when discussing Lave's work, because of her exceedingly broad use of the term "activity", which seems to be necessitated by her not using the distinction activity vs. action highlighted by Scribner (see previous subsection).

11. She also discusses other examples from Cline-Cohen (1982), including one showing commercial mathematics as one of the structuring resources for the 18th century British arithmetic curriculum.

12a. Lave considers the concept of learning transfer (especially from academic to practical situations) to be central to explanations of the basis of continuity of activity across settings, as well as to the celebration of the claimed superiority of "scientific" over everyday thought.

12. The quotation also shows the tension between the idea of an objective "structure" which reflects a determinate predominance of structuring resources and therefore which leads to a specific response being "expected" from subjects, and the image of a negotiated outcome depending on the subject's "conclusions" and perceptions of the experimenter's intentions.

13. Because of the low variance in the correctness scores from shopping, or more precisely, ceiling effects - the 98% correctness score apparently is produced by only one error by only one subject in the 56 "math problems in supermarket" in Appendix Table 1 (pp.72-3) - all correlations with shopping from this point on refer to the frequency of calculation, rather than to the correctness of the result.

14. Besides the reactivity involved in interviewing or "experimental simulations" - being approached in such a way may make people feel they have to respond in the school maths way - which Lave rightly warns against, there is a similar possible source of reactivity in the observation in the supermarket. Shoppers may perform as if they were making decisions in a purely rational "best-buy" manner; for example,

> [Buying] the five pounds [bag twice] would be four dollars and 32 cents, versus four dollars and 30 cents [for the ten-pound bag]. I guess I'm going to have to buy the ten-pound bag just to save a few pennies....
> (Shopper, quoted in Murtaugh, 1985, p.190)

Murtaugh interprets this shopper as comparing "prices for ten pounds of sugar, the quantity she already has decided to purchase". However, for me, the formulation "I guess I'm going to have to ..." raises the question of whether this shopper is attempting to display a "rational" performance.

15. One supermarket was in S. California (n = 50 low/middle income women), and one in Cambridge, Mass. (n = 100 middle income women). A young female interviewer asked: "Suppose

this were a product you used a lot of...(and) you had a choice between these two sizes. How could you tell which one is the better buy?" (Capon and Kuhn, 1979, p. 450). The researchers attempted to assure "motivation" by offering each subject one chance in a $50 lucky draw for each correct answer to one of the two problems offered.

16. The instructions for the best buy problems were as follows:

> Now I have some problems of this type for you to do. Each problem will have two or three items, either the actual items or written on notecards, and I want you to tell me which one gives you the most for your money.... [If the subject said they could not decide, or the problem was too difficult] What information would you need to answer this question? Tell me exactly what needs to be done to help you decide and I will use this calculator to get any intermediate steps done.
>
> (Lave, 1988, p.106)

17. There was no difference in level of correct performance on the AMP problems depending on the form of presentation - viz. bottles and jars, or information on cards. This is relevant to the analysis of my interview problems in Chs. 10 and 11.

17a. Lave, in emphasising the level of correct answers, does not address the reasons for this slight disparity. The problem is that only the use of strategies (5) and (6) guarantee that the solution to a (P/Q ratio type) problem is correct - as a mathematical task. Otherwise, grading answers primarily for correctness on questions like these that involve choosing one of two goods as a best buy, as Lave et al. did, allows a subject who doesn't know the answer to guess, perhaps "correctly". (See also the discussion of my interview results on a similar best-buy item in Sec. 10.2 below.)

18a. Lave's two most difficult questions are F and G; see column "C" in Table 19, p.112. Again Lave's emphasis on the level of correct answers - 81% - for these two questions (see Table 14, p.109) is somewhat misleading, for comparisons with Capon and Kuhn.

18. Lave gives other "suggestive" evidence for this claim: in the AMP, there was a positive relationship between the number of years of schooling and correct performance on school-like tests, but not between schooling and correct performance on best buy simulations (nor between schooling and "performance" (NOTE 13 above) in supermarket settings); there were similar results in Scribner's dairy study. However, there was a correlation between level of education and the strategy used in Capon and Kuhn (1982).

19. Table 18 (p.112) which refers to all 12 of their problems appears to support their judgements about strategy type, in that subjects did appear to match their strategies to Lave et al.'s problem types. Nevertheless there was some deviation on the 8 "P/Q ratio-type" problems: 47% used a

P/Q ratio strategy, and 39% used a unit price strategy (see also Table 10.7(a)).

19a. Yet for the researchers to judge that subjects matched strategies to problems requires not only deciding that there is a "proper" strategy for each type of problem, but also then being able to distinguish problem "types". It is not certain that the distinction is so clear between price / quantity (P/Q) ratio-type problems, and unit price-type ones. For example, one problem in the AMP best buy simulations is:

(K) sunflower seeds   A 3 oz. for 30c
                         B 4 oz. for 44c

Lave et al. classify this as a unit price-type problem (unit prices 10c per oz. and 11c respectively), with A the best buy. However, one could consider it a P/Q ratio-type problem, and compare the P ratio, a "disguised" 2:3, with the quantity ratio, 3:4, to see that you pay 50% less for A while suffering only a 33% drop in quantity, thus making A better value.

Further, for the respondent to make "the proper match" would involve assessing each problem, before calculating, as to which - price / quantity ratios, or unit price ratios - would be "easier" to calculate and to compare. It also requires judging whether a ratio like 77c/41c "really is" a "disguised" 2:1 ratio, and whether it is recognisable as such by subjects, or not.

20a. Making judgements about difficulty is itself difficult: AMP considered 3:2 as a "difficult" ratio, based on observation of subjects' shopping, whereas Capon and Kuhn considered 3:2 as "simple" (1979,p. 450-1), presumably in some mathematical sense.

20. This moralism around being able to do maths in the correct way may help to explain teachers' impatience with students who can't do it, and students' feelings of unpleasantness and guilt; see the discussion of the interviews in Chs. 10 and 11.

21a. Indeed, there may be some tension between the idea of a "mix" of structuring resources, and that of a "discontinuity" between activities, if the latter is understood as too sharp a disjunction.

21. A systematic way of making such relations is what is provided by considering activities as "discursive" practices, and by using the linguistic terminology of "signified" and "signifier"; see the discussion of Walkerdine's work in the next section.

22. From this point onwards, I shall use the terms "practice" and "discourse" as broadly interchangeably with "discursive practice". Sometimes, a distinction corresponding to the distinction activity vs. action highlighted by Scribner (see previous section) will be used to clarify the term "practice" as it is used in the work of Walkerdine and her colleagues rather broadly.

23. See e.g. Habermas (1992) and recent issues of Radical Philosophy.

24. However, Brenner describes the Vai teachers' sensitivity to what might be threatening to the pupils (1985, p.184), and Cobb in NOTE 6 above refers to teachers' practices that could produce negative affect; e.g. "imposition" strategies by "authority" figures, use of unfamiliar symbols or procedures peculiar to formal maths. So the affective aspects have not gone unnoticed, but they have usually not been at all central to the analysis.

NOTES - Chapter 8

1. See the first quotation from Carraher et al. (1987) in Sec.7.3.

1a. In formal learning, by contrast, "what is being taught, instead of who is doing the teaching, becomes paramount. Children are expected to learn by relating themselves solely to subject matter and by disregarding their relationship with the teacher; they are likely to see a new teacher each semester, if not each hour." (Scribner and Cole, 1973, p.556)

2. There are certain resemblances between Skemp's cybernetic theory as deployed by Buxton, and the "cognitive-constructivist" theory of Mandler and McLeod discussed in Ch.3; for example, the origins of anxiety for both are in the interruption of a goal-directed plan. This point cannot be further discussed here. Further, both of these views differ from those based on activity theory and post-structuralism, in that they assume the existence of an individual neatly separable from "the external world", a view challenged by some of the latter theorists; see Sec. 7.4 and 7.5.

3. Both Maxwell (1989) and Winter (1987), instead of "mathematics anxiety", prefer the term "mathophobia", defined as "excessive ... irrational and impeditive dread" by Resek and Rupley (1980), since the latter connotes both fear and dislike.

3a. The repressed chain is produced by "primal" repression, which brings about the original "entry of the drive into psychical life" (Thom, 1981, p.17).

4. Especially before Lacan's work became known in English (Lacan, 1977), "desire" ("wunsch" in Freud's German) tended to be translated into English as "wish". In much of the work discussed below, e.g. Walkerdine, Taylor, Hollway, the term tends to be used rather broadly - so that it often seems to mean something similar to "libidinal energy" (Laplanche and Pontalis, 1973, pp.481-3 and 239-40).

4a. These operations link the "manifest dream-text" and the "latent dream-thoughts"; see Sec.3.2.

5. As an illustration, Thom comments on the analysis of

"Philippe's dream", discussed in Lacanian writings. The formation of a dream depends on three inputs:
(i) daytime residues, e.g. an experience such as going for a walk;
(ii) internal somatic excitations, e.g. thirst resulting from having eaten salty herrings;
(iii) fulfilment of a (repressed) wish arising in the context of events from the past, e.g. the "desire" to drink. Thus this desire to drink is represented metaphorically in Philippe's dream by the gesture of cupping one's hands, and by the formula "J'ai soif" ("I am thirsty"), uttered by another person in one of Philippe's associations with the dream. The operation of metonymy can be illustrated, after the uncovering in analysis of the centrality of Philippe's mother's cousin, Lili, by the association of her name with "lit" ("bed", itself a metonymy for Lili's satisfying marriage), and with "lolo" (French baby-talk for "breast", "milk").

This dream illustrates the process of repression as understood by Lacan; see Fig. 8.1. If, in the first sign, the signified s is the need to drink, and S is the signifier "soif" ("thirst"), then, when S falls to the level of the signified in the second sign, then the new signifier S' is Lili's saying "Phillippe, j'ai soif" ("I am thirsty").

6. For an example of an associative chain produced at the request of the <u>interviewer</u>, see the transcript and the analysis of the interview with Fiona in Ch. 11.

6a. Nimier poses the question: What is it about maths that provokes these different feelings? He suggests that it has to do with the characteristics of mathematical language:
(a) the unambiguous terms - e.g. "it's that or it isn't that" in the quote above;
(b) the rigid syntactic rules; and
(c) the small amount of (or lack of) redundancy.
All this means, in Nimier's view, that mathematics is a language whose function is to "make differences appear". Now, the first difference is that of sex, and all differences come from there. Therefore doing mathematics could well mean confronting castration anxiety. Nimier also argues (paraphrasing Freud) that "to express itself, the unconscious must take account of mathematical language" (pp.169-170).

6b. Nimier's typology of defences against anxiety appears itself to be based on a sort of "splitting" of mathematics into "bad" and "good". Now, while splitting is a primitive <u>defence</u> in Kleinian theories, basing one's analysis on such a division seems odd. Indeed, it appears somewhat difficult to distinguish defences A3 and B2 - both might be seen as attempts towards "mastery" (see next section) - and the linking of B2 with splitting seems to undermine the original A / B division.

7. For a possible illustration of such relations with the father, see the discussion of the interview with Fiona in Ch. 11.

7a. This result was reported orally at the 1987 PME Conference. For a possible illustration of such relations with the family, see the discussion of the interview with Alan in Ch. 11.

8. The inadequacy of this naming as a way of providing a "natural" definition of the context has been discussed in Ch.7.

9. "Projection", a term susceptible to a wide range of uses, is here used in its psychoanalytic sense of a defence whereby qualities, feelings, wishes which the subject refuses to recognise, or rejects in him/herself, are rejected from the self and located in another person or thing (Laplanche and Pontalis, 1973, pp.349-356).

10. A fuller discussion of these issues is provided by Edward Said's (1978) study of the West's views of "the Orient", and by Michael Rustin's psychoanalytic study of racism (1991); see also Henriques (1984).

10a. Grieb and Easley (1984) present an analysis of "pale male math mavericks" which has affinities with Walkerdine's description of the boy fantasising Reason's dream, but which focusses on the double-binds to which such boys and their teachers are subject.

11. The originary moment for Freud for understanding unconscious fantasy was the infant's loss of its mother's breast. Subsequently, the infant gains a sense of fulfilment of wishes (or desires) - though never full satisfaction - through processes produced by the unconscious such as dreams and fantasies: these involve "the restoration of signs which are bound to the earliest experiences of satisfaction" (Laplanche and Pontalis, 1973, pp.481-483), along with transformations and transpositions through a series of condensations and displacements. Though full satisfaction is never possible, the infant needs to embark on "filling the gap", of mastering the loss. Freud gives the example of a young child's play with a cotton reel, which he argues provides the child with a fantasy of being able to control the mother, masking the child's powerlessness and dependency (Walkerdine, 1988, pp.190-191; Urwin, 1984).

11a. For some corroboration of the widespread fantasising of Reason's dream, see Nimier (1978, p.170; in particular, the second quotation from "FC, 18 years").

12. Walkerdine argues that all the instances of play with objects she observed in the school were "at the same time the production of a fantasy and the insertion into an imaginary discursive practice (1988, p.195).

12a. We should note also that taking up a subject-position marks a relation of power within a particular discourse - even if "only" in fantasy. An instance is given by the two girls who negotiate for positions of power at the start of an episode of play in the Wendy House (Walkerdine, 1982 and sec. 7.5.1 above). Thus Urwin (1984) discusses and illustrates the "power - desire - knowledge complex", and argues that the workings of desire are influenced by power relations.

13. Henriques et al. signal their aim to understand the analysis of signification in the unconscious, not as pre-given language rules, but as discursive relations produced through positioning within discourses. Since discursive practices and relations are historically specific, so too will be the content of unconscious processes. Illustrations are given in Ch.11; see e.g. Ellen's case study.

13a. We might also say that these discursive practices are "fluid". A method of analysis which aims to be sensitive to changing patterns of signification over the course, say, of an interview or series of interviews will be described briefly in Hollway's work, and developed in my own; see below and Ch.11.

14. Further, Taylor distinguishes between a subject's "interdiscursive" shifts, e.g. between positioning in interview and in test contexts, and "interitem" shifts, e.g. between calling up the "bread" discourse and the school maths, in response to two ostensibly similar problems (pp.242-3). This distinction can be related to a distinction between "positioning" and "calling up" in the discussion of my interviews; see sec.8.5 and Ch.10 where I also allow for "interdiscursive positioning". Taylor himself does not appear to use the concept of "interdiscursive positioning" - possibly because his empirical material consists of test results and interviews where his subjects seem to be relatively laconic and inarticulate: as well as being young, they were presumably speaking a second or third language.

14a. Hollway investigated gender "identity" and gender-differentiation in heterosexual relationships in a study of a group of people aged 30+ in London in the early 1980s. The research material was produced in interviews, from transcripts of the meetings of an ongoing human relations group, from a residential weekend, and from her own journal.

15. Clearly, other major dimensions of social difference such as class, race and age interact with gender to make certain positions more or less likely to be taken up.

15a. See NOTE 22, Ch.7.

16. Otherwise, we are left with an explanation in terms of "social physics" (e.g. one subject exerting a "force" on another), or merely a reporting of what all the actors say, or no explanation at all.

17. Henriques et al. expect

> multiple positionings, correspnding to a multiplicity of subjectivities ... [which] must refer to the specifities of the different practices in order to describe the different subject positions and the different power relations played out in them. [One]

cannot simply speak of a specific subject's behaviour and attitudes or ascribe in advance the subject's position according to class or gender."

(1984, p.117)

The possible positioning in a mix of practices is called "inter-discursive positioning" by Walkerdine; see Ch.7. There may of course be contradictions or conflicts between aspects of these positions; these may be held together in the unconscious; see Sec. 8.3 and especially the discussion of Will in sec. 8.4.2 above.

NOTES - Chapter 9

1. For a somewhat different approach, see Silverman (1985, Ch.5).

2. In June 1984, I did 4 "pilot" interviews, two based on Sewell's method, and two based on Hoyle's methods. Subsequently, for 1985 and 1986, the synthesised method was adopted since it seemed to be able both to elicit displays of respondents' thinking about the problems and to elicit emotional responses and reports.

3. It will be noted that the interview was aimed firmly at producing research material, rather than at interventions - say to do with overcoming maths anxiety, or maths "consciousness-raising". Thus, for example, Sheila Tobias' maths diagnostic interview (see Sec. 8.2) was not considered appropriate. Nevertheless, the interviews were designed and run to be generally affirmative of the subjects (and certainly not undermining) - and there were positive, though largely unplanned, outcomes in "consciousness-raising" terms; see Harriet's case study in Ch.11.

4. However, in practice, Qu.3 seemed to call up school maths for many respondents; see Sec.10.3. Qu.4 and subsequent problems seemed to be considered as everyday or "practical" by most respondents, perhaps because the contexting questions were especially elaborate for Qu.4 itself; see Sec.10.4.

5. However, Qu.9 turned out to be "recognisable" and of interest to at least one woman interviewee, Jean, a hockey player, as well as to male football and rugby players. In any case, the Polytechnic where the study was completed had a female football team, as well as male teams, by the mid-1980s.

6. Some of these indicators for "exhibited anxiety" appear to be indicators for anxiety itself, rather than for defences, e.g. frequent and/or nervous laughter, or impatience to know the "right answers".

7. Since there were different numbers of students across most of the 12 categories of the working population, the sampling fraction varied from 17% - for young middle class women and mature "mixed" class women - to 100% - for mature "mixed" class men.

8. The results of the recruitment process in full were as follows. An estimated 5 students were not contacted - as inferred from the continuing presence of my letter in their pigeonhole after a week or two: some students checked their pigeonholes very infrequently. A further 15 (estimated) were contacted, but did not respond. Five more responded but too late to interview; four responded and were offered a time, but for various reasons the interview could not be arranged. These, along with the three refusals and the 16 completed interviews made up the original 48 students invited.

9. The tape recorder was placed unobtrusively in a partly-open drawer of a filing cabinet in 1986 (at the suggestion of interviewee no.10), and on the table at which the interviewee and I sat, in 1985. In addition, I took notes in all interviews.

9a. Since almost all tutor's offices were the same size as mine and in the same building, all interviewees would have been in a similar room during their first year of studies.

10. The workshop, called "Learning to Cope Brilliantly with Numbers" was run on slightly different lines in the two years. In 1984-85, the emphasis was on talking about difficult problems or experiences people had had with maths: there was a small number of fairly regular attenders, including three of the 9 students interviewed that June. In 1985-86, the emphasis was on a systematic coverage of areas of maths - mostly arithmetic, as specified by the "Diagnostic Booklets" used on the course: more people enrolled, including two of that year's 16 interviewees, but the attendance of most was sporadic. The current emphasis of the workshop is on problem-solving (see Evans, in preparation).

10a. The detailed results were: 8 "not known", 7 "acquainted", and 10 "known fairly well". The latter group included Fiona (no.5), Donald (no.10), Harriet (no. 16) and Alan (no.7) - all of whom are reported as detailed case studies in Ch.11, and nos. 9, 1, 2, 4 (Keith), 8 and 12. The "not known" group included Jean (no.3), Ellen (no.14) and Peter (no.19), who were the other three detailed case studies reported in Ch.11.

11. Miles and Huberman's approach appears to be based on parallels with the analysis of survey data in a data matrix, where each row represents a case (usually an individual) and each column represents one variable, and the entries are generally values of a quantitative indicator. In their work, the rows of the matrix can again be cases (institutions, events, as well as individuals), and the columns are variables. But the entries in the matrix are now often elements of text; these elements may be "talk" from an interviewee - or they may be descriptions of one event or one aspect of a setting in a sample, say the "ethos" of an institution (cf. Rutter et al., 1979). Sometimes these tables can be used to examine what are analogous to "correlations", but using rather more qualitative "data", across the sample.

12. For social class, the sample is divided into three parental occupations: middle class, working class, and "mixed"; for discussion of this latter breakdown, see sec. 5.6.1.

13. For Jean, as for the other nine interviewees from June 1985, the social class of the parents had to be inferred, since there were no questions on social class in the autumn 1984 questionnaire. Where the student did not mention the occupation of his / her parents, the inference was made on the basis of cues such as accent, and expressed views e.g. on money.

NOTES - Chapter 10

1. For some purposes, we might consider two practices within academic maths - namely those to do with teaching, e.g. doing tutorials, and those to do with testing. Similarly, we might consider two forms of the research interview - let us call them the structured interview (SI) and the less structured, "life history" interview (LH) - with respect to the difference in positions offered to "interviewer" and "interviewee"; compare for example the discourses of interviewing in, say Moser and Kalton (1971) and Hammersley and Atkinson (1983).

2. One man (no.8) was not asked to attempt the question (see Sec. 10.5) and one woman produced an answer that she claimed immediately was a "guess" (interview no.15).

3. For further discussion of a practice including the action or reading quantitative information, which might be called "critical citizenship", see Ch.12 and Evans (1990).

4. It may be useful analytically to distinguish multiple positioning from inter-discursive positioning - the latter based on an intersection of discourses (Evans and Tsatsaroni, 1993) - though this distinction is not made in the relevant literature, e.g. Henriques et al. (1984).

5. Of the six responses coded "SM" for Qu.18, four of these - Donald, Peter, Ellen and no.22, the other woman with A-level in Maths - all responded "37.2p" for the 10% tip; the other two, interviewees no.18 and no.24, both used written methods on the questionnaire form. (Of course, as indicated in the text above, some other respondents may have done written calculations for Qu. 18, but may not have handed them in with the questionnaire.)

6. However, on closer examination, the "interitem" analysis in Table 10.1 is not really parallel to Taylor's analysis of "metonymically similar" bread and cake versions, because one of the questions in my interview is abstract, and the other is "culturally embodied" in tipping practices. Taylor (1990a, Ch.7) does not show the details of any interdiscursive analysis.

7. Thus, for 10% of 6.65, he took {(10% of 6) + (10% of .6)

+ (10% of .05)}; this was also basically one of Peter's two mental methods. On decomposition, see Plunkett (1979), who however does not apply the idea to the taking of percentages.

7a. Only one of the three subjects who presented their answers in money terms, rather than in the abstract terms of the question, was classed as "SM", since she used laborious written methods which appeared to have been learned in school (though she finished up with an approximately correct answer: "86p"). In a more detailed analysis, the "interdiscursive" quality of her positioning could be explored.

8. Indeed, Donald gave a noteworthy response to part A: after choosing the period of fastest price rise by eye - as did all other subjects, he volunteered to "count a line", which I took to mean calculate the gradients of the lines for the two periods, and compare them. This he did with acceptable accuracy. See his case study in Ch.11.

8a. Interestingly, the results from a "similar" question, Qu.20 on the questionnaire, to do with reading from a graph the temperature at "the hottest time of day", show that, of 23 of the interview sample completing the questionnaire, only one got the question wrong, and two others did not attempt it (presumably having run out of time). This is despite the fact that the questionnaire test was completed under more difficult conditions - including a time limit - and most subjects would be presumed to be positioned in academic maths. But, on the interview question, performance was much less good. The explanation may be simply that the photocopy of the graph was difficult to read. Or it may be that, for Qu.20 on the questionnaire, each square on the graph represented one Celsius degree, whereas here each square represented \$5, not \$10, and the subject had to count down from \$600 to reach the right answer.

9. There are several further issues, to do with whether or not the application of the rule is unconditional or <u>conditional</u> on the service or the food etc., or on how much money the subject has; we might call the first two <u>intrinsic</u> factors, and the latter subjective or <u>financial</u> factors. The financial factors might be distinguished according to whether they are seen as <u>chronic</u> - as with Jean, a working class woman (see Ch.11), or <u>transitory</u> - as with no.17 (Sam), a young black man, apparently "laid-back".

Also we might note what intrinsic aspects are focussed on. For example, two of the three black subjects stipulate: "It depends on how well they treated me" (no.17), and "it'd depend on how comfortable I felt, the atmosphere, and so on" (no.6, a young woman - transcript, p.6) - whereas the third, no.24 (an older former nurse), presented her rule as straightforwardly dependent on whether the service was "good" or "lousy". Note also that nos.17 and 24 were two of the three subjects who suggest leaving a certain <u>amount</u> as a tip.

9a. It is interesting that this subject presented an "inappropriate" answer for this question, since she did not do so in the questionnaire, completed during the first week of the course (nine months before). On the other hand, none of the subjects who gave this sort of inappropriate ans. (37.2p) to Qu. 18 on the questionnaire - among them, Dennis, Ellen and Peter - did the same here; see the cross-tabulation of positionings for Qu. 18 and this question, in Table 10.2.

10. As Carraher et al. (e.g. T. Carraher, 1988) have shown, decomposition is a useful method for oral strategies.

11. For example, no.4 (Keith) in Qu.2; see his illustration in APPENDIX U2. In general, this suggests that what are often called "reactive effects" or a lack of "ecological validity" (see the discussion of the work of Michael Cole et al. in Ch.7) might be considered as a consequence of the subject's positioning in discursive practice(s).

12. No.24, who was used to eating out on special occasions with other nurses, first gave an apparently wild answer to "10% of £3.81", viz. "£1.80", which I classed as "wrong". At the end of her interview, I suggested she come back to discuss some of the questions, since her performance had suggested that she was subject to several crucial misconceptions. When we were going over the percentage questions an hour or so later, she gave the correct answer immediately, and recalled that she had answered a larger tip because the first part of the question had asked only how much she would leave without asking for 10%. A look at the transcript shows this to be a plausible interpretation.

13. However, she also said in the later session that she didn't like people to watch her while she was working questions. This suggests that anxiety about the interview may have been an important factor in several cases; see also the case study of Ellen in Ch.11.

14. No.13 (a man, 25+, former electrician) was one of several subjects who extracted from the wage slip "gross pay to date" (£1335.450), rather than "gross pay this period" - besides no.9 and no.22 (a young woman who worked part-time as book-keeper for a large firm). Though this move was not classed as a slip, in some cases, one could ask whether it was "motivated": for example, as a former stockbroker, no.9 might well have been paid around £1300 <u>per month</u> gross in 1984 before joining the course - or at least have known people who were.

15. One who did not notice was no.13 who, after beginning so thoughtfully (see text), did the multiplication "9 x 13" in long form as "207" - which was a surprising slip !

16. Of the five judged to have called up PM, at least three would find the action of scutinising payslips familiar:
no.2 - who had checked many wageslips at work (see above);
no.4 - who had dealt with records at work (and whose father was an accountant); and
no.21 - who had managed her own business.
Less certain to be familiar with such tasks were no.13 - who

had been an electrician, and Ellen - who did not have much payslip experience, but who had Maths A level (and who therefore was likely to be interdiscursively positioned for Qu.5B). All but no.13 got part B correct. (See NOTE 15 above.)

Among the 12 calling up SM, only four or five would have had similar work experience:
no.22 - who worked part-time as a bookkeeper and who had A-level Maths, the only one classed as SM-positioned to got part B correct;
no.1 - who had helped employees of her firm sort out their payslips;
Harriet - who had checked many of her own payslips (see Ch.11);
no.9 - a former stockbroker; and perhaps
Fiona - who claimed to have been a "financial advisor, broking basically" (transcript, p.3) and whose father was a stockbroker (see Ch.11).

17. But she is not familiar with percentages: earlier in the interview, this subject made two false starts in answering Qu.2 [10% of 6.65], and then refused to try either Qu.4 or Qu.5, the other two percentage questions.

18. Gender differences were considered less relevant to thinking for this problem; in any case, the only differences were that 2 of 7 men were coded as "guess", and 2 of 7 women as a slip or error.

19. She also "loathed " shopping and did not ever buy ketchup; see the discussion of a "motivated" slip, in Ellen's case in Ch.11.

20. This analysis would be "relational" cf. Hollway and / or historical cf. Walkerdine; see Sec. 8.4.

21. This recalls the idea that elements of discourse do not have to be verbal; cf. sec. 7.5.1.

22. These steps are reminiscent of the four steps in "the typical use of mathematics in the real world" as outlined in Davis and McKnight (1980, pp. 41-42), or the four stages in a statistical investigation (Graham, 1990, Ch.1).

23. The importance of the context, especially the social relations therein, can be appreciated by going through this exercise again - e.g. for tipping a taxidriver.

NOTES - Chapter 11

1. The ways in which anxiety may be an effect of the "floating" of the signifier (i.e. its functioning without a fixed meaning), so that it is "claimed" by or associated with more than one discourse cannot be pursued here; further research is needed. It is also needed for the question of whether, and under what circumstances, anxiety "originating" in connection with other ideas may become "attached" to mathematical concepts and calculations.

2. Note that this "statement" is reminiscent of one reported by Nimier (see sec. 8.3.2) where the "rigour" of mathematics was celebrated.

3. More generally, we can note what may be the use of Ellen's mathematical competence to defend herself against anxiety across a range of spheres (cf. Walkerdine (1985, 1988), where however the argument focuses on the tendency of males to follow this pattern of defence.) Besides the example of her adding up the cost of her meal at the restaurant because she does not "want to be an expense", there are others: e.g. adding up the cost of the goods in her shopping trolley, so as to ensure that they total less than £15 [responding to Qu.6]; and checking payslips and/or bank statements to ensure that "they've got it all right [laughs] - it doesn't always happen...." [Qu.5, p.9]. It should be stressed, however, that these uses of numeracy are by no means confined to herself.

4. Indeed, in what Ellen says, her position within the relationship, is (implicitly) referred to by a quantitative, quasi-mathematical term. This recalls the literature on the commodification of relationships, particularly in the context of women's economic dependency on men; see e.g. Barrett (1980).

4a. Sometimes the associations between the problems posed and the subject's responses to the contexting questions - (C) whether "this (problem) reminds you of anything else you do these days" and (R) whether "this reminds you of any earlier experiences" may <u>seem</u> bizarre; e.g. Ellen's association of dividing recipes for 4 into recipes for 2, with Qu.2 ["10% of 6.65"]. It is not always possible to pull out a comprehensible chain of meanings for any particular association, because of the limitations of the interview material, and of course the basis of the associations may not be fully conscious. However, psychoanalytical insights may help: the discussion of the meanings attached to "being an expense" above, and to "peeling oranges" by Hollway, show how meaningful associations may be recovered.

5. I did not ask Jean to calculate a 15% tip, as I did with Ellen, even though there was also a "pretext" in that Jean was soon to leave for the USA. Note that she does manage to calculate "a 15% tip" on 6.65, with my help, when we do a "reprise" of the percentage questions (transcript, p.17).

5a. Jean also calls up school maths college maths for Qus. 1 and 3. A basis for understanding her calling up of school maths and maths tests early in the interview may be provided, at least partly, by the unscripted aspects of my performance as interviewer. When I give her Qu.1 [reading a pie chart], I say "I'm going to give you some paper too, in case you need it, a couple of sheets over there...." (transcript, p.4). And when I give her Qu.2: "Again you've got some paper there if you want it" (p.4). I attempt to reassure her - "... no, no, you didn't have to study up for this ... " (p.5); but I make a slip when I refer to the interview problems as "this test" (p.8, just before presenting Qu.3). These moves on my part - more "regulating" than I was with other subjects - would tend to reinforce her positioning in school maths. (For a possible explanation, see the indication of my relative inexperience at the time that I did this interview, in the Reflexive Account.)

6. In addition, for academic maths practices, the way Jean was placed in different "sets" at school is likely to relate to social class (e.g. Ball, 1981). At school, Jean was in the top set for the first three years of comprehensive school, then was moved to the 3rd set. She seems ambivalent about losing the top set maths teacher who was "very strict", for the 3rd set treacher who was "too soft" and was "walked all over" by the students. The change also involved leaving students who were "more intelligent", though also perhaps "snobs", to go to the set where her friends were, though they "talked too much" and "didn't work in class" Most of her team-mates from the hockey team were in top set. Overall, it was better to be with her friends in the 3rd set, because the top set teacher was so frightening, but she might have got O-level maths if she had stayed there. This account of part of her "life history" gives some insight into the differing cultures of different sets at her school. These relate in turn to differing experiences in learning maths.

6a. However, Jean does express some confidence in the interview. For example, "Yeah, I was good at pie-charts" (around age 11) (p.4); and "I feel quite competent for what I need in real life" (p.18).

7. The residual for PERFS is obtained by subtracting the "predicted" score from the observed score; the predicted score is calculated by substituting the values for the student's maths qualifications, age, TA score, etc. into the equations for the models for PERFS given in Sec. 6.3.2 (Table 6.5). Since the standard error of estimate for the "whole sample" model is about 1.4 questions, the size of the residual in, say, Fiona's case - 1/2 to 3/4 of a question - is not too large.

7a. The prominence of the theme of "sudden decline" is perhaps not surprising, given that the students could in effect decide to accept an invitation to attend or not: having such a history would perhaps motivate attendance. It was described by men as well as women, and the process as perceived by subjects showed a great deal of particularity. For a discussion of ideas about a generalised discontinuity of girls' performance in maths around the transition to secondary school, see Walden and Walkerdine (1985); for a discussion of "sudden decline", see Tobias (1978).

8. This recalls another example, when two young boy pupils attempt to resist their (woman) teacher's instructions by shifting to a sexist discourse through playing with words; see Walkerdine et al. (1989, pp.65-66).

9. See also the reported fantasies of Peter, most of which do not end up as completely successful.

9a. As did interviewee no. 24, another woman of working class background, who worked for some time before entering the course.

10. A. Brown (1990) bears on issues of "home-school communication".

10a. Rather than the sorts of "problem-solving" or investigations that have been promoted in maths education in recent years. However, this is not surprising, since she was at secondary school between 1970 and 1975.

11. It is a debatable point as to whether the way Harriet's father related to her not knowing how to do a particular problem would be read by her as "en-couragement". We might speculate that, <u>if</u> her father was anxious about <u>his</u> not knowing, he might have projected that onto her, and she might have taken over his anxiety, since she was supposed to "have" something he didn't - knowledge. Perhaps for him to en-courage her, he would have had to be less anxious about his own not-knowing.

12. Her five wrong on the SM scale are made up of 3 slips (two based on the error "9 x 3 = 36"), and two not attempted, both of the form "Which is the largest number of ... ?".

12a. Another possible interpretation for Harriet's pleasure: the formula keeps the anxiety, the discomfort, the panic at bay. The area in which she felt "uncomfortable" in the past, and to which she resists exposing herself in the interview, is percentages. One explanation might be that straightforward formulae are not so easily remembered, nor so readily available in textbooks (as they are for, say, gradients or statistics).

13. Indeed, I would say that Alan very shrewdly assessed just how much he had to "spend time working it out" for the interview; in particular, who would urge him to go beyond his approximate calculation of "about £6" for a wage rise that turns out, on an exact basis, to be £5.99 ?

13a. Similar is interviewee no.9, another middle class man, who wishes he had his calculator and notes in the interview.

14. Possibly Donald is using the score "2" or "1" as the "base line" or neutral point for his anxiety reports, rather than "4" as intended; if this were so, the comparability of

his scores with those of other students would be vitiated.

15. Donald seems, however, to avoid agreeing with this interpretation (pp. 15-16).

16. Note, however, the relatively satisfactory quality of this fantasy, compared with the "panic" felt about imagining a similar situation by no.8; see Sec. 10.5.

16a. An exception is Qu. 4 [10% tip on chosen meal - chicken for £3.75] which seems to call up eating in restaurants, since he talks about what the waiter might think of him (p.17). Peter's response - "37 1/2p" - given almost immediately - may be a (precise) response from a practical discourse (since the 1/2 p coin had only just been phased out by 1986). Or it may indicate an interdiscursive positioning: he does not say "37.5 p" - which would indicate school maths, nor 37p or 38p - which would suggest practical maths and be reasonably precise.

17. Perhaps this is to warn me not to expect very much, nor to be surprised if he fails. Perhaps it is also "rational", as it means he may be less likely to be shouted at.

17a. The only other interviewee to mention it explicitly was Keith (see APPENDIX U2), whose father also represented mastery in maths - but only up to a point.

18. The comparison of Alan's and Fiona's views with those of other subjects, e.g. Donald, Jean and Harriet may also allow us to develop Walkerdine's ideas about the difference between "calculation for survival" and "calculation as a theoretical exercise" (1990b, p.52).

18a. This lower middle class position in also consistent with his account of deciding how much to tip: "You don't think about how much you've had, more about what the waiter thinks is fair [..] or stingy" (p.17). This diffidence, this concern about doing what the waiter thinks is right, this anxiety about what the waiter might do if you don't, can be contrasted with, say, the confidence of interviewee no.9, an upper middle class male, towards waiters (see sec. 10.4(a)).

19. Actually, the <u>number of cases</u> analysed in Chs. 10 and 11 compares favourably with the numbers used by the Lave, Murtaugh and de la Rocha team (n=25 in the supermarket and n=10 in dieting), and by Taylor (n=4 interviewees). However, in both these other projects, the interaction was more <u>intensive</u> - about 40 hours with each subject for Lave et al., and three or four interviews with each for Taylor.

20. Another way affect works is through its part in the learner's beliefs that the task / subject is one "I can do" - or not (cf. HMI, 1989). The relationship between "hot" emotions of anger, frustration, anxiety, etc. and "cooler" attitudes of lack of confidence, avoidance, dislike, etc. merits further research, using approaches such as those used in this thesis.

21. Bernstein also suggests that

> Any collection code [i.e. system with strong classification] involves an hierarchical organisation of knowledge, such that [...] only the few _experience_ in their bones the notion that knowledge is permeable, that its orderings are provisional, that the dialectic of knowledge is closure and openness. For the many, socialization into knowledge is socialization into order, the existing order, into the experience that the world's educational knowledge is impermeable. Do we have here another version of alienation?
>
> (Bernstein, 1971, p.57; his emphasis)

In mathematics, the hierarchical organisation of knowledge seems especially marked, and hence the impenetrability of the subject or at least parts of it may provide the basis of seeing it, or parts of it, as _alien_. But the emotional _charge_ of that alienation is provided by the formative experiences and the investments that are part of the history / biography of the particular subject.

22. Further, when we note Fiona's norm that the male was usually left to pay the restaurant bill, we can understand better how it might be that members of an "oppressed group" might actually have an "investment" (in the sense used here) in oppressive practices, e.g. sexist ones.

NOTES - Ch. 12

1. Similarly, within my sample, the fact the the correlation between the performance measures for SM and PM was no more than moderate offered some mild support - but _only_ mild support - for the notion that these were indicators of different types of performance (see Sec.5.3).

2. This emphasis on specificity may suggest there will be difficulties in teaching numeracy. This problem needs further work, but for a start, see the notion of "critical citizenship" in Sec. 12.4 below.

3. Examples of different aspects of numeracy, as characterised here, are abundant in the interviews. No.9 (stockbroker) uses decomposition of the sum to be percentaged in Qu.5 and Qu.2; this is a _strategy_ described by Carraher et al. for oral maths, and was unlikely to be learned by this subject in maths at school. Harriet and no.21 (woman manager) do very accurate mental _approximations_ for 9% in Qu. 5; no.13 attempts an elegant one: 9% of £1335 = 9 x £13. As examples of _critical evaluation_, Ellen and no.22 scrutinise their answers for "15% of... " and "9% of... " in Qus. 4 and 5 respectively; on the basis of its not "looking right", each finds a slip. Sam rejects a wage increase of "pence per week" in Qu. 5 as too small, an example of knowing the "_solution shape_" (Lave) in advance. Finally, an example of _flexibility_ - and boldness: no.11, tells a story of working for the summer as a hotel porter, and finding himself pressed into service to serve drinks one busy night in the hotel; he tells of dealing with the problem of giving change under these conditions by handing

over a pile of coins!

4. The factor analysis, for example, suggested that some items previously classed as practical (NA) might instead be understood as describing school-type (TA) anxiety situations; see Sec. 6.1.

5. In other variants, "state" or transient anxiety is measured, and/or other measurements are used; see Secs. 3.2 and 8.2.

6. Questions about the "origins" of anxiety in the subject's history cannot be pursued here.

6a. In relation to earlier findings about the cognitive / affective relationship, many psychologists have referred positively to "the Yerkes - Dodson Law" suggesting an "inverted U" relationship between performance and anxiety as "one of the few laws produced so far by psychology" (Levitt, 1968). But not all have taken the implications into consideration when designing their research: it has been typical to see results for the anxiety - performance relationship presented in the form either of a difference in mean performance between two groups (high and low anxiety) or as a linear (Pearson) correlation between anxiety and performance scores. Neither setup will allow a relationship in the form of an "inverted U" to be confirmed <u>or</u> refuted.

7. Yet the finding of the inverted U, because of its elegance, is especially difficult to give up to the rigours of critical questioning along the lines developed here; at one point in my work, I called my reluctance to do so "positivist withdrawal symptoms".

7a. However, the inverted U relationship between SM performance and maths test anxiety can be used to pick out "deviant" cases - in the sense of "bad fits" to the model - which might be of especial interest. Here, two of the seven case studies represent less "good fits" - Harriet and, to a lesser extent, Alan. In Harriet's case, I argue that her "confidence-lacking" approach to the performance items was likely related to her positioning in school maths and especially in homework. An examination of his questionnaire suggests Alan may have answered the set of anxiety items in a peculiar way. See Ch.11 for further details.

8. These ideas might be developed further, by conjecturing that less clear thinking may result either from "memory failure" or misconceptions, or from an emotional block, an interference with <u>attention</u> resulting from negative emotion. This would require defining attention more carefully, perhaps as the "inverse" of a blockage, and would require specifying "negative emotion". We can provisionally include anxiety, dislike, boredom, diffidence, not-valuing, anger, etc.

9. For a critique of the basic assumptions of cognitivism, see Tsatsaroni (1991), as well as Walkerdine (1988) and Lave (1988).

10. An illustration of the difficulties of predicting or controlling transfer comes from Donald's responses to Qu.3A [comparing gradients for parts of the graph of the gold price]. Though this might seem promising as a case of successful transfer from work practices to college maths, it may demonstrate merely that he has learnt to solve the problem from within each discourse separately. Though he seems to display the ability to "translate" from the basic terms of one discourse to the other, thereby showing his awareness of the "discursive overlap", the two practices are differently regulated: for example, the answer he produces in the work discourse may not be sufficiently precise to be evaluated as correct in SM. Indeed, in Donald's view, working in the money markets "is no help at all with mathematics" (his transcript, p.14).

11. For example, the computer software "Shopping on Mars", available to schools, aims to develop "intuitive maths" skills (Hennessy et al., 1989).

11a. For example, see Walkerdine's discussion of the different meanings of "more" and "less" at home and at school (Sec.7.5). With these limits in mind, nevertheless, I have read Walkerdine's account (1988, Ch.6) of how an experienced primary school teacher moves from "everyday examples" of addition to a "translation" within school maths, while carefully relating signifier and signified, as an example of potentially successful harnessing.

12. For example, at Middlesex University, recent community research / research methods projects done by 2nd year Social Policy and Social Work students include: students' income and spending patterns; the need for greater spending on books in the library; the effects of closure of a children's ward at a local hospital.

13. A general discussion of the variety of ways of combining qualitative and quantitative research cannot be provided here; see e.g. Bryman (1988, esp. Ch.6) and Evans (1979).

13a. In some cases, a subject developed numeracy through work practices: e.g. for Donald, working in the money markets; for no.9, stockbroking. Sometimes, they developed a facility in academic maths: for Harriet, having to teach children school maths in the residential home helped later with college maths; for Donald, the first year Methods and Models course helped him discover an interest in maths for the first time.

14. See e.g. Levine (1982) and Hamilton and Stasinopoulos (1987) and the references therein.

14a. Paulos (1990) and Moore (1990) both emphasise the importance of the idea of chance and of statistical thinking.

15. The findings here have opened up some further puzzles. What other bases might there be for the "low performers" among the low-qualified, older females in both my questionnaire and interview samples? And is it worth trying

to describe further the "mixed" social class position in my sample, and to explain their low performance on the questionnaire? See Ch.6 for further discussion.

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APPENDIX P1 Gallup Survey for ACACE: Interview Schedule and Cards

1. How much would it cost you altogether to buy a cup of coffee at 17p and a sandwich at 24p? (Read out and show CARD 1)

   ANSWER (write in): ....

   Method: 1 Oral
   2 With writing
   3 Calculator used

   Response: 4 Confident
   5 Unconfident

   6 Immediate
   7 'Pause for thought'

2. How much does it cost to buy eight 14p stamps? (Read out and show CARD 2)

   ANSWER (write in): ....

4. Which is bigger, three hundred thousand or a quarter of a million? (Read out and show CARD 4)

   ANSWER (write in): ....

   Method: 1 Oral
   2 With writing
   3 Calculator used

   Response: 4 Confident
   5 Unconfident

   6 Immediate
   7 'Pause for thought'

BREAK

5. If you buy five Xmas cards for 65p, how much is each card costing you? (Read out and show CARD 5)

Question 3

CARD 3

This is a restaurant bill. If you wanted to leave a 10% tip, how much would the tip be?

Soup		.35p
Main course		£2.20p
Sweet		.68p
Coffee		.30p
	Total	£3.53p

Question 6

CARD 6

Here is a railway timetable. I live in Leicester and have arranged to meet a friend at the station in London at 4 o'clock in the afternoon. Assuming the trains run on time which is the *latest* train I can get from Leicester to arrive in time for the meeting?

Mondays to Fridays

Leicester dep.	*London* arr.
01.36	03.52
02.20	05.22
05.00	07.34
06.17	08.18
06.52	08.47
07.17	09.02
07.33	09.12
08.07	09.45
08.23	09.50
08.34	10.11
08.55	10.36
09.11	10.45
09.33	11.36
10.22	12.06
10.40	12.50
11.27	13.08
11.42	13.40
12.27	14.08
12.48	14.59
13.25	15.02
13.44	15.42
14.27	16.10
14.42	16.52
15.31	17.13
15.44	17.42
16.27	18.08
17.13	18.51
17.28	19.10
17.53	19.55
18.27	20.05
19.30	21.03
19.41	21.42
20.30	22.04
21.24	23.31

Question 7

CARD 7

Suppose that the rate of inflation had dropped from 20% to 15%, which one of these results would you have expected:

(a) Prices would have gone down, or

(b) Prices would have stayed the same, or

(c) Prices would still be rising but not as fast as before, or

(d) Prices ought to have gone down but didn't

8. If you bought a raincoat in the 'summer sales' reduced from £44 to £29.50, how much would you save? (Read out and show CARD 8)

ANSWER (write in): ....

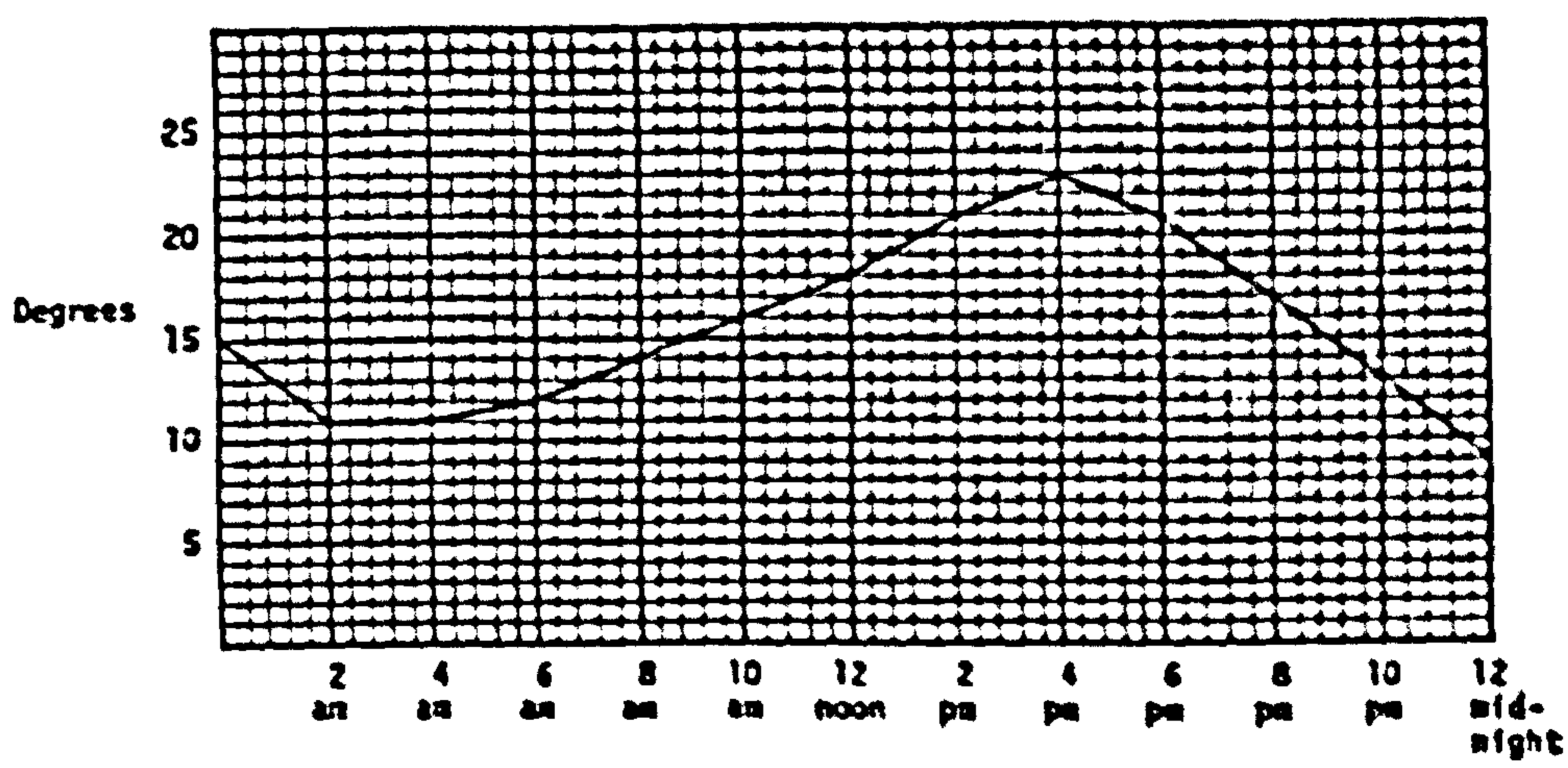
Method: 1 Oral
2 With writing
3 Calculator used

Response: 4 Confident
5 Unconfident
6 Immediate
7 'Pause for thought'

Question 9

CARD 9

This shows you the temperature changes on a hot day last summer. What was the hottest time of day? And how hot was it then?



Question 10

CARD 10

25% OFF

ALL MARKED PRICES

If you saw this sign in a shop, would you expect to pay:

a half, or
three-quarters, or
a quarter, or
a third
of the original price?

Source: ACACE (1982, pp. 20-24)

APPENDIX P2 The NCDS 4th Follow-up: the Literacy and Numeracy Questions

1. As you probably know, thousands of adults have difficulties with reading or writing at one time or another. It would help us if you could answer some questions about your own experience of reading and writing.

   a. Since leaving school have you had problems with reading?

   b. Since leaving school have you had problems with writing or spelling?

   Those who answered 'Yes' to either question 1a or question 1b were then asked:

2. Do these problems now make anything difficult for you in everyday life? What things in particular are made difficult for you?

3. Since leaving school have you had problems with number work or basic maths?

   Those who answered 'yes' to question 3 were then asked:

4. Do these problems now make anything difficult for you in your everyday life? What things in particular are made difficult for you?

   People who had had any problems with reading, writing, spelling or number work since leaving school (i.e. who answered 'Yes' to either Q1 or Q3 above) were then asked:

5. Is there anything that you would like to do that you feel lack of reading or number skills prevents you from doing? What things in particular are you prevented from doing?

6. I would now like to ask you about any classes or courses you have done since leaving school which did not lead to formal educational qualifications. I am interested in any courses you have done – evening classes, courses you have followed on television, courses organised by Trade Unions and so on. Since leaving school, have you ever taken any courses or classes to

   a. get better at reading or writing?

   b. get better at figures or arithmetic?

Source: Hamilton and Stasinoupoulos (1987, p.74)

APPENDIX P3 The Fennema - Sherman Mathematics Anxiety Scale (MAS)

1. Math doesn't scare me at all. (+)
2. It wouldn't bother me at all to take more math courses. (+)
3. I haven't usually worried about being able to solve math problems. (+)
4. I almost never have gotten shook up during a math test. (+)
5. I usually have been at ease during math tests. (+)
6. I usually have been at ease in math classes. (+)
7. Mathematics usually makes me feel uncomfortable and nervous. (-)
8. Mathematics makes me feel uncomfortable, restless, irritable, and impatient. (-)
9. I get a sinking feeling when I think of trying hard math problems. (-)
10. My mind goes blank and I am unable to think clearly when working mathematics. (-)
11. A math test would scare me. (-)
12. Mathematics makes me feel uneasy and confused. (-)

Source: Fennema and Sherman (1976)

Note: The weight of each item (+ or -) is shown in brackets.

APPENDIX P4 1972 Version Mathematics Anxiety Rating Scale (MARS).

NAME ______________________ Total Score __________

MATHEMATICS ANXIETY RATING SCALE (MARS)

The items in the questionnaire refer to things and experiences that may cause fear or apprehension. For each item, place a check (✓) in the box under the column that describes how much you are frightened by it nowadays. Work quickly but be sure to consider each item individually.

	Not at all	A little	A fair amount	Much	Very much
1. Determining the amount of change you should get back from a purchase involving several items.	☐	☐	☐	☐	☐
2. Having someone watch you as you total up a column of figures.	☐	☐	☐	☐	☐
3. Having someone watch you as you divide a five digit number by a two digit number.	☐	☐	☐	☐	☐
4. Being asked to add up 976 + 777 in your head.	☐	☐	☐	☐	☐
5. Dividing a five digit number by a two digit number in private with pencil and paper.	☐	☐	☐	☐	☐
6. Calculating a simple percentage, e. g., the sales tax on a purchase.	☐	☐	☐	☐	☐
7. Listening to a salesman show you how you would save money by buying his higher priced product because it reduces long term expenses.	☐	☐	☐	☐	☐
8. Listening to a person explain how he figured out your share of expenses on a trip, including meals, transportation, housing, etc.	☐	☐	☐	☐	☐
9. Having to figure out how much it will cost to buy a product on credit (figuring in the interest rates).	☐	☐	☐	☐	☐
10. Totaling up a dinner bill that you think overcharged you.	☐	☐	☐	☐	☐
11. Telling the cashier that you think the dinner bill was incorrect and watching the cashier total up the bill.	☐	☐	☐	☐	☐
TOTAL	___	___	___	___	___

	Not at all	A little	A fair amount	Much	Very much
12 Being treasurer for a club.					
13 Totaling up the dues received and the expenses of a club you belong to.					
14 Adding up 976 + 777 on paper.					
15 Doing a word problem in algebra.	☐	☐	☐	☐	☐
16. Solving a problem such as: If x = 11, and y = 3, then the results of x/y is equal to ______?	☐	☐	☐	☐	☐
17. Solving the problem such as: If x = 12, and y = 4, then the ratio of x to y is equal to ______?	☐	☐	☐	☐	☐
18. Determining the grade point average for your last term.	☐	☐	☐	☐	☐
19. Reading an article on the basketball team, showing what percentage of free throws each player made, the percentage of field goals made, the total number attempted, etc.	☐	☐	☐	☐	☐
20. Reading an historical novel with many dates in it.	☐	☐	☐	☐	☐
21. Counting the number of pages left in a novel you are engrossed in.	☐	☐	☐	☐	☐
22. Guessing at the number of people attending a dance you're at.	☐	☐	☐	☐	☐
23. Buying a math textbook.	☐	☐	☐	☐	☐
24. Watching someone work with a slide rule.	☐	☐	☐	☐	☐
25. Watching a teacher work an algebraic equation on the blackboard.	☐	☐	☐	☐	☐
26. Signing up for a math course.	☐	☐	☐	☐	☐
27. Listening to another student explain a math formula.	☐	☐	☐	☐	☐
28. Walking into a math class.	☐	☐	☐	☐	☐
TOTAL	___	___	___	___	___

	Not at all	A little	A fair amount	Much	Very much
29. Having to compute the miles/gallon on your car.					
30. Watching someone work with a calculator.					
31. Looking through the pages of a math text.					
32. Working on an income tax form.					
33. Reading your W-2 form (or other statement showing your annual earning and taxes).					
34. Studying for a math test.					
35. Starting a new chapter in a math book.					
36. Walking on campus and thinking about a math course.					
37. Meeting your math teacher while walking on campus.					
38. Reading the word "Statistics."					
39. Sitting in a math class and waiting for the instructor to arrive.					
40. Solving a square root problem.					
41. Signing up for a course in Statistics.					
42. Checking over your monthly bank statement.					
43. Taking the math section of a college entrance exam.					
44. Having someone explain bank interest rates as you decide on a savings account.					
45. Raising your hand in a math class to ask a question.					
46. Reading and interpreting graphs or charts.					
TOTAL					

	Not at all	A little	A fair amount	Much	Very much
47. Reading a cash register receipt after your purchase.	☐	☐	☐	☐	☐
48. Figuring the sales tax on a purchase that costs more than $1.00.	☐	☐	☐	☐	☐
49. Having a person illustrate to you the best way to divide your money into a savings and a checking account.	☐	☐	☐	☐	☐
50. Figuring out which of two summer job offers is the most lucrative: where one involves a lower salary, room and board, and travel, while the other one involves a higher salary but no other benefits.	☐	☐	☐	☐	☐
51. Reading a formula in chemistry.	☐	☐	☐	☐	☐
52. Hearing a lecture in a social science class where the instructor is commenting on some figures, e. g., the percentage of each socio-economic group who voted Republican.	☐	☐	☐	☐	☐
53. Taking an examination (quiz) in a math course.	☐	☐	☐	☐	☐
54. Taking an examination (final) in a math course.	☐	☐	☐	☐	☐
55. Hearing two of your friends exchanging opinions on the best way to calculate the cost of a product.	☐	☐	☐	☐	☐
56. Having someone ask you to recheck his figures in a simple calculation, such as division, or addition.	☐	☐	☐	☐	☐
57. Being asked by a friend to answer the question: how long will it take to get to Denver if I drive at 30 miles per hour?	☐	☐	☐	☐	☐
58. Studying for a driver's license test and memorizing the figures involved, such as the distances it takes to stop a car going at differing speeds.	☐	☐	☐	☐	☐
59. Hearing friends make bets on a game as they quote the odds.	☐	☐	☐	☐	☐
60. Playing cards where numbers are involved, e. g., bridge or poker.	☐	☐	☐	☐	☐

	Not at all	A little	A fair amount	Much	Very much
61. Hearing a friend try to teach you a math procedure and finding that you cannot understand what he is telling you.					
62. Scheduling my daily routine to allocate set times for classes, for study time, for meals, for recreation, etc.					
63. Juggling class times around at registration to determine the best schedule.					
64. Deciding which courses to take in order to come out with the proper number of credit hours for full time enrollment.					
65. Working a concrete, everyday application of mathematics that has meaning to me, e. g., figuring out how much I can spend on recreational purposes after paying other bills.					
66. Working on an abstract mathematical problem, such as: "If x = outstanding bills, and y = total income, calculate how much you have left for recreational expenditures."					
67. Being given a set of numerical problems involving addition to solve on paper.					
68. Being given a set of subtraction problems to solve.					
69. Being given a set of multiplication problems to solve.					
70. Being given a set of division problems to solve.					
71. Picking up the math text book to begin working on a homework assignment.					
72. Being given a homework assignment of many difficult problems which is due the next class meeting.					
73. Thinking about an upcoming math test one week before.					
74. Thinking about an upcoming math test one day before.					

	Not at all	A little	A fair amount	Much	Very much
75. Thinking about an upcoming math test one hour before.					
76. Thinking about an upcoming math test five minutes before.					
77. Talking to someone in your class who does well about a problem and not being able to understand what he is explaining.					
78. Waiting to get a math test returned in which you expected to do well.					
79. Waiting to get a math test returned in which you expected to do poorly.					
80. Walking to math class.					
81. Realizing that you have to take a certain number of math classes to fulfill the requirements in your major.					
82. Picking up a math textbook to begin a difficult reading assignment.					
83. Being called upon to recite in a math class when you are prepared.					
84. Not knowing the formula needed to solve a particular problem.					
85. Receiving your final math grade in the mail.					
86. Opening a math or stat book and seeing a page full of problems.					
87. Being responsible for collecting dues for an organization and keeping track of the amount.					
88. Getting ready to study for a math test.					
89. Listening to a lecture in a math class.					
90. Figuring out your monthly budget.					
TOTAL	___	___	___	___	___

	Not at all	A little	A fair amount	Much	Very much
91. Being given a "pop" quiz in a math class.					
92. Seeing a computer printout					
93. Having to use the tables in the back of a math book.					
94. Being told how to interpret probability statements.					
95. Asking your math instructor to help you with a problem that you don't understand.					
96. Being asked to explain how you arrived at a particular solution for a problem.					
97. Tallying up the results of a survey or poll.					
98. Acting as secretary, keeping track of the number of people signing up for an event.					
TOTAL	___	___	___	___	___

Total Score ____________________

APPENDIX Q1 Questionnaire for Polytechnic Sample D83

DO NOT WRITE YOUR NAME ON ANY OF THE ATTACHED SHEETS

NAME______________________________

CODE Number:________________________

The following questions were designed to find out about your experiences with, skills in, and feelings about numbers or "maths". The results for the group as a whole will be used in helping this year's courses to work better, and for further studies by several members of staff aimed at making maths less painful for students in general. Results will be fed back to your group of students as soon as possible. Your name will be detached from the answer sheet when it is analysed and stored; results will be used only on an anonymous basis.

BLANK IN ORIGINAL

Mathematics Experience Scale

These questions ask you about your experiences with mathematics so far. (PLEASE TICK OR FILL IN YOUR ANSWER AS REQUIRED).

1. What Set(s) on the Dip H.E. are you most interested in?.....................

2. What is Your age (as at 1st Sept.) .... years.

3. Male .... or Female ....

4. Qualifications you have in Maths? A level... O level ... CSE ... Other ... (PLEASE SPECIFY) ....

5. How much difficulty have you experienced in Maths courses generally before attending the Polytechnic? i.e. at school or F.E. college?
   None ......
   A small amount ....
   A moderate amount ..
   A great deal ...
   (PLEASE TICK ONE)

6. How much difficulty have you experienced in using Maths generally in your everyday life, e.g. in checking your change, in measuring a room to buy carpet or paint.
   None ....
   A small amount ....
   A moderate amount ..
   A great deal ....

7. How much difficulty do you expect to have with Maths in your studies at the Polytechnic?
   None ....
   A small amount ....
   A moderate amount ..
   A great deal ....

8. Please assess your own skill in each of the following areas.
   (PLEASE CIRCLE THE MOST APPROPRIATE LETTER IN EACH CASE)

   A = Very capable B = Fairly capable C = Not very capable
   D = Not at all capable

i	BASIC OPERATIONS (+,−,x,÷)	A	B	C	D
ii	FRACTIONS	A	B	C	D
iii	PERCENTAGES	A	B	C	D
iv	DECIMALS	A	B	C	D
v	BASIC ALGEBRA	A	B	C	D
vi	GRAPHS	A	B	C	D

9 Is there anything special you would like to learn in Maths in QM100/101; for example, from the list above, or otherwise?

....
....
....
....

Mathematics Performance Scale

This scale is a measure of how people cope with numerical problems when they have to answer them under test conditions. It is NOT a test of underlying mathematical ability or potential. You should not expect to complete all of the items on this scale. Please attempt the items in the order they are presented and do not skip an item unless you feel 'stuck'.

You may use any blank spaces on this sheet for calculations.

1. How much would it cost you altogether to buy a cup of coffee at 17p and a sandwich at 24p ?

   ANSWER ....

2. How much does it cost to buy eight 14p stamps ?

   ANSWER ....

3. Which is bigger (a) three hundred thousand or (b) a quarter of a million ?

   ANSWER ....

4. If you buy five Xmas cards for 65p, how much is each card costing you ?

   ANSWER ....

5. If you bought a raincoat in the 'summer sales' reduced from £44 to £29.50, how much would you save ?

   ANSWER ....

6. **25% OFF**
   ALL MARKED PRICES

   If you saw this sign in a shop, would you expect to pay:
   (a) a half, or
   (b) three quarters, or
   (c) a quarter, or
   (d) a third

   of the original price ?

   ANSWER ....

7. 27 + 33 = ...

8. 124 + 56 - 73 = ...

Maths Performance Scale (continued)

9. 91 ÷ 7 = ...

10. 13 x 9 = ...

11. If X = 3 then 9X = ...

12. If X = 4 then X + 7 = ...

13. If 4Y = 68, then Y = ...

14. Suppose the rate of inflation had dropped from 20% to 15% which one of these results would you have expected:

(a) Prices would have gone down, <u>or</u>

(b) Prices would have stayed the same, <u>or</u>

(c) Prices would still be rising but not as fast as before, <u>or</u>

(d) Prices ought to have gone down but didn't.

ANSWER ....

15. Which of the following numbers is the greatest (a) 0.76 (b) 0.768 (c) 0.08

ANSWER ....

16. 13.8 - 0.73 + 5.9 = ...

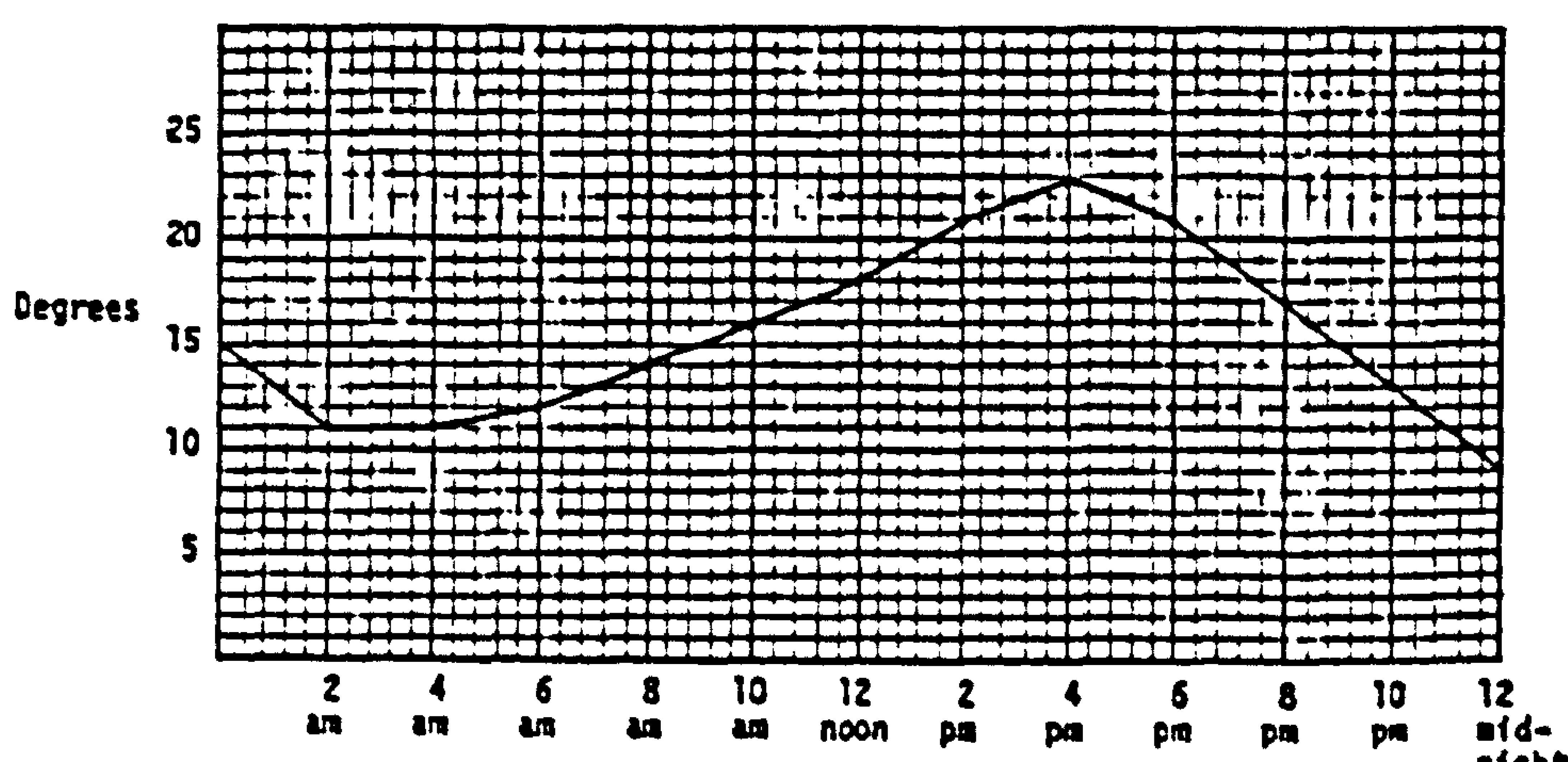
17. The ages (in years) of five people in a group are 18, 20, 22, 25, 30. What is the average age of the group ?

ANSWER ....

18. Suppose you go to a restaurant and the bill comes to a total of]3.72p. If you wanted to leave a 10% tip, how much would the tip be ?

ANSWER ....

19. This shows how the temperature changed during a hot day last summer.



What was the hottest time of day ? ANSWER ....

20. How hot was it at the hottest time of day ? ANSWER ....

21. In an opinion poll for a bye-election where there were two candidates 44% of those polled said they would vote for Jones, 22% said they did not know.
The rest said they would vote for Smith. What percentage said they would vote for Smith?

ANSWER ....

22. Whom would you expect to win ?

ANSWER ....

23. How confident are you about this prediction ?

(a) totally certain (b) fairly confident (c) not very confident (d) not at all confident.

ANSWER ....

WHY? ....

24. If the "don't knows" are excluded, what are the percentages of the remaining voters (i.e. of those who have expressed a preference) who say they will vote for the two candidates ?

(a) Smith ....
(b) Jones ....

Middlesex Polytechnic

Situational Attitude Scale

For each of the following items please indicate to what extent you would generally feel either relaxed or anxious in the situations they describe. Please rate the situations according to your immediate feelings, on the following scale:

1. I would be very relaxed.
2. I would be relaxed.
3. I would be fairly relaxed.
4. I would be neither relaxed nor anxious.
5. I would be a little anxious.
6. I would be moderately anxious.
7. I would be very anxious.

	Very Relaxed 1	Relaxed 2	Fairly Relaxed 3	Neither Relaxed Nor Anxious 4	A Little Anxious 5	Moderately Anxious 6	Very Anxious 7
1. Determining the amount of change you should get from a purchase involving several items.							
2. Asking a stranger which bus to catch in a strange town.							
3. Enrolling for a course which includes a compulsory mathematics component.							
4. Buying a recommended mathematics textbook.							
5. Calculating which is the cheapest method of getting somewhere by public transport.							
6. Dividing a five digit number by a two digit number in private with pencil and paper.							
7. Finding a street in an A to Z street atlas.							
8. Walking into a room before a maths class.							
9. Listening to another student explain a maths formula.							
10. Having someone watch you as you total up a column of figures.							
11. Adding up 976 +777 on paper.							
12. Asking someone to do you a favour.							
13. Listening to a lecture in a maths class.							
14. Totalling up a restaurant bill where you think you are being overcharged.							
15. Walking into school or college and thinking about a maths course.							

	1 Very Relaxed	2 Relaxed	3 Fairly Relaxed	4 Neither	5 A Little Anxious	6 Moderately Anxious	7 Very Anxious
16. Choosing an item of clothing.							
17. Reading your P60 (or other statement) showing your annual earnings and taxes.							
18. Being asked a question by the teacher in a maths class.							
19. Being responsible for keeping track of the amount of subscriptions collected for an organisation.							
20. Sitting in a mathematics class and waiting for the teacher to arrive.							
21. Deciding which film to go an see yourself.							
22. Reading a cash register receipt after you have bought something.							
23. Raising your hand in a maths class to ask a question.							
24. Figuring our V.A.T. at 15% on a purchase which costs more than one pound.							
25. Taking an examination for a maths course.							
26. Climbing a ladder.							
27. Working out a concrete, EVERYDAY APPLICATION, of mathematics that has meaning to you; e.g. calculating how much you can spend on leasure activities after paying other bills.							
28. Realising that you have to do a certain number of maths classes in order to complete your degree.							
29. Raising your hand to ask a question in an English class.							
30. Being given a set of numerical problems involving addition to solve on paper.							
31. Getting the result of a maths diagnostic test.							
32. Being asked a question by the teacher in an English class.							
33. Working out your monthly budget.							
34. Getting the result of an English diagnostic test.							
35. Completing a surprise maths quiz.							
36. Talking in a group of strangers (people from a similar social background to yourself, but unknown to you).							
37. Doing this questionaire.							

APPENDIX Q2 Questionnaire for Polytechnic Samples C84 & D84

DO NOT WRITE YOUR NAME ON ANY OF THE ATTACHED SHEETS

NAME ....

CODE Number..

The following questions were designed to find out about your experiences with, skills in, and feelings about numbers or "maths". The results for the group as a whole will be used in helping this year's courses to work better, and for further studies by several members of staff aimed at making maths less painful for students in general. Results will be fed back to your group of students as soon as possible. Your name will be detached from the answer sheet when it is analysed and stored; results will be used only on an anonymous basis.

BLANK IN ORIGINAL

Experience Scale

These questions ask you about your experiences with mathematics so far. (PLEASE TICK OR FILL IN YOUR ANSWER AS REQUIRED).

1. What Set(s) on the Dip H.E. are you most interested in?
   ....

2. What is Your age (as at 1st Sept.) ..... years.

3. Male ...... or Female ......

4. How much would you say you use numbers generally in your everyday life?
   Not at all..........
   A small amount......
   A moderate amount...
   A great deal........
   (PLEASE TICK)

5. How much difficulty have you experienced in using numbers generally in your everyday life, e.g. in checking your change, in measuring a room to buy carpet or paint.
   None ....
   A small amount......
   A moderate amount...
   A great deal ....

6. How much have you used numbers in work situations (including housework)?
   Not at all..........
   A small amount......
   A moderate amount...
   A great deal........

7. How much difficulty have you experienced in using numbers in work situations (including housework)?
   None................
   A small amount......
   A moderate amount...
   A great deal........

8. Qualifications you have in Maths? A level........ O level..... CSE...... Other.......(PLEASE SPECIFY) ....

9. How much difficulty have you experienced in Maths courses generally before attending the Polytechnic? i.e. at school or F.E. college?
   None...............
   A small amount.....
   A moderate amount...
   A great deal........
   (PLEASE TICK ONE)

10. How would you rate yourself now in each of the following areas? (PLEASE CIRCLE THE MOST APPROPRIATE LETTER IN EACH CASE)

    A = Very capable B = Fairly capable C = Not very capable
    D = Not at all capable

i	BASIC OPERATIONS (+,−,x, ÷) ON WHOLE NUMBERS	A	B	C	D
ii	FRACTIONS	A	B	C	D
iii	PERCENTAGES	A	B	C	D
iv	DECIMALS	A	B	C	D
v	BASIC ALGEBRA	A	B	C	D
vi	GRAPHS	A	B	C	D

Experience Scale

11. How much difficulty do you expect to have with Maths in your studies at the Polytechnic?

    None ....
    A small amount......
    A moderate amount...
    A great deal ....

12. Is there anything special you would like to learn in Maths in QM100/101 - or during your studies generally; for example, from the list above, or otherwise?

    ....
    ....

PLEASE DO NOT GO ON TO THE NEXT PART, UNTIL WE ASK YOU TO DO SO.

Performance Scale

This scale is a measure of how people cope with numerical problems when they have to answer them under test conditions. It is NOT a test of underlying mathematical ability or potential. You should not expect to complete all of the items on this scale. Please attempt the items in the order they are presented and do not skip an item unless you feel 'stuck'.

You may use any blank spaces on this sheet for calculations.

1. How much would it cost you altogether to buy a cup of coffee at 17p and a sandwich at 24p?

   ANSWER.......................

2. How much does it cost to buy eight 14p stamps?

   ANSWER.......................

3. Which is bigger (a) three hundred thousand or (b) a quarter of a million?

   ANSWER.......................

4. If you buy five Xmas cards for 65p, how much is each card costing you?

   ANSWER.......................

5. If you bought a raincoat in thge 'summer sales' reduced from £44 to £29.50, how much would you save?

   ANSWER.......................

6. **25% OFF**
   ALL MARKED PRICES

   If you saw this sign in a shop, would expect to pay:
   (a) a half, or
   (b) three quarters, or
   (c) a quarter, or
   (d) a third
   of the original price?

   ANSWER ....

Performance Scale (contd.)

7. 27 + 33 = ...

8. 124 + 56 - 73 = ...

9. 91 - 7 = ...

10. 13 x 9 = ...

11. If Z = 4 then Z + 7 = ...

12. If Z = 3 then 9Z = ...

13. If 4Y = 16, then Y = ...

14. Suppose the rate of inflation had dropped from 10% to 6% which one of these results would you have expected:

(a) Prices would have gone down, or
(b) Prices would have stayed the same, or
(c) Prices would still be rising but not as fast as before, or
(d) Prices ought to have gone down but didn't.

ANSWER......................

15. Which of the following numbers is the greatest (a) 0.76 (b) 0.768 (c) 0.08. ANSWER...........................

16. 13.8 - 0.73 + 5.9 = ...

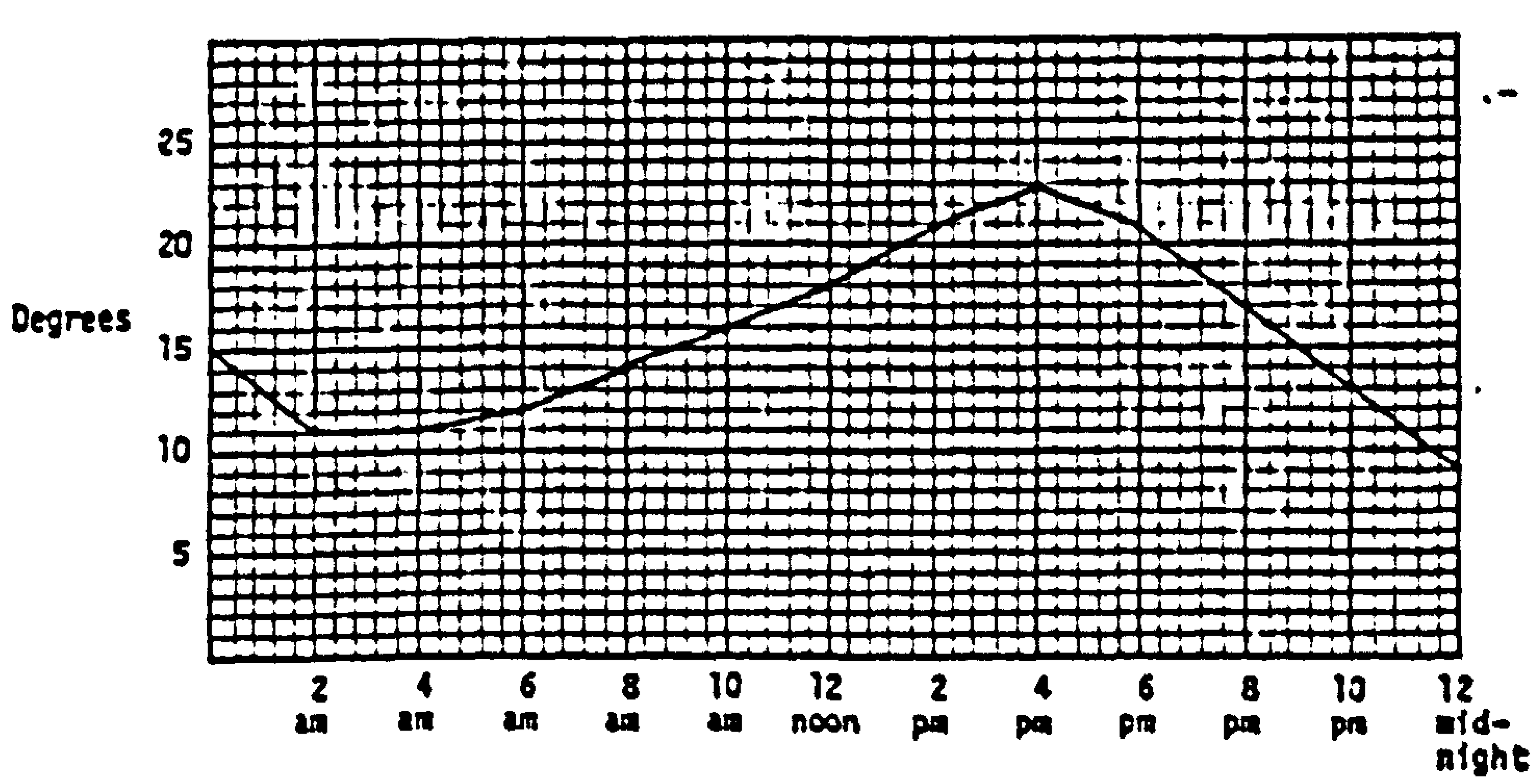
17. The ages (in years) of five people in a group are 18, 20, 22, 25, 30. What is the average age of the group ?

ANSWER......................

18. Suppose you go to a restaurant and the bill comes to a total of £3.72p. If you wanted to leave a 10% tip, how much would the tip be?

ANSWER ....

19. This shows how the temperature changed during a hot day last summer.



What was the hottest time of day? ANSWER.................

Performance Scale (contd)

20. How hot was it at the hottest time of day? ANSWER..........

21. In an opinion poll for a by-election where there were two candiates 44% of those polled said they would vote for Jones, 34% said they would vote for Smith, the rest said they did not know. What percentage said they did not know?

    ANSWER..................

22. Whom would you expect to win ?

    ANSWER..................

23. How certain do you think this prediction is?

    (a) totally certain (b) fairly certain (c) not very certain (d) not at all certain.

    ANSWER..................

    WHY?..
    ....

24. If the "don't knows" are excluded, what are the percentages of the remaining voters (i.e. of those who have expressed a preference) who say they will vote for the two candidates?

    (a) Smith.......

    (b) Jones.......

Middlesex Polytechnic

Situational Attitude Scale

For each of the following items please indicate to what extent you would generally feel either relaxed or anxious in the situations they describe. Please rate the situations according to your immediate feelings, on the following scale:

1. I would be very relaxed.
2. I would be relaxed.
3. I would be fairly relaxed.
4. I would be neither relaxed nor anxious.
5. I would be a little anxious.
6. I would be moderately anxious.
7. I would be very anxious.

	1 Very Relaxed	2 Relaxed	3 Fairly Relaxed	4 Neither Relaxed Nor Anxious	5 A Little Anxious	6 Moderately Anxious	7 Very Anxious
1. Determining the amount of change you should get from a purchase involving several items.							
2. Asking a stranger which bus to catch in a strange town.							
3. Enrolling for a course which includes a compulsory mathematics component.							
4. Buying a recommended mathematics textbook.							
5. Calculating which is the cheapest method of getting somewhere by public transport.							
6. Dividing a five digit number by a two digit number in private with pencil and paper.							
7. Finding a street in an A to Z street atlas.							
8. Walking into a room before a maths class starts.							
9. Listening to another student explain a maths formula.							
10. Having someone watch you as you total up a column of figures.							
11. Adding up 976 +777 on paper.							
12. Asking someone to do you a favour.							
13. Listening to a lecture in a maths class.							
14. Totalling up a restaurant bill where you think you are being overcharged.							
15. Walking into school or college and thinking about a maths course.							

	1 Very Relaxed	2 Relaxed	3 Fairly Relaxed	4 Neither	5 A Little Anxious	6 Moderately Anxious	7 Very Anxious
16. Choosing an item of clothing.							
17. Reading your P60 (or other statement) showing your annual earnings and taxes.							
18. Being asked a question by the teacher in a maths class.							
19. Being responsible for keeping track of the amount of subscriptions collected for an organisation.							
20. Sitting in a mathematics class and waiting for the teacher to arrive.							
21. Deciding which film to go an see yourself.							
22. Reading a cash register receipt after you have bought something.							
23. Raising your hand in a maths class to ask a question.							
24. Figuring our V.A.T. at 15% on a purchase which costs more than one pound.							
25. Taking an examination for a maths course.							
26. Climbing a ladder.							
27. Working out a concrete, EVERYDAY APPLICATION, of mathematics that has meaning to you; e.g. calculating how much you can spend on leasure activities after paying other bills.							
28. Realising that you have to do a certain number of maths classes in order to complete your degree.							
29. Raising your hand to ask a question in an English class.							
30. Being given a set of numerical problems involving addition to solve on paper.							
31. Getting the result of a maths diagnostic test.							
32. Being asked a question by the teacher in an English class.							
33. Working out your monthly budget.							
34. Getting the result of an English diagnostic test.							
35. Completing a surprise maths quiz.							
36. Talking in a group of strangers (people from a similar social background to yourself, but unknown to you).							
37. Doing this questionaire.							

APPENDIX Q3 Questionnaire for Polytechnic Sample B85

Anonymous Code Number ....

DO NOT WRITE YOUR NAME ON ANY OF THE ATTACHED SHEETS

NAME ....

The following questions were designed to find out about your experiences with, skills in, and feelings about numbers or "maths". The results for the group as a whole will be used in helping this year's courses to work better, and for further studies by several members of staff aimed at making maths less painful for students in general. Results will be fed back to your group of students as soon as possible. Your name will be detached from the answer sheet when it is analysed and stored; results will be used only on an anonymous basis.

B85

BLANK IN ORIGINAL

Experience Scale

These questions ask you about your experiences with mathematics so far. (PLEASE TICK OR FILL IN YOUR ANSWER AS REQUIRED).

1. What Track(s) on B.A. Social Science (e.g. Psychology, Social Policy) are you most interested in?........................

2. What is Your age (as at 1st Sept.) ..... years.

3. Male ...... or Female ......

4. What, if any, has been your most recent paid work? (PLEASE SPECIFY FULLY AND IN PRECISE DETAIL)
   .... or ....None to date.

   IF 'None to date' PLEASE GO DIRECTLY TO QUESTION 5.

   How long ago did you last do this job?........................

   Was it ....full time or ....part time?

5. What is/was your father's paid work when you began secondary school?

   ....or ....No Paid work or.........Don't know.

6. What is/was your mother's paid work when you began secondary school?

   .... or ....No Paid work or ....Don't know.

7. What was the main language you spoke at home while you were growing up?

   ....English or Other (PLEASE SPECIFY).................

8. How much would you say you use numbers generally in your everyday life? e.g. in checking your change, in measuring a room to buy carpet or paint?
   Not at all..........
   A small amount......
   A moderate amount...
   A great deal........
   (PLEASE TICK)

9. How much difficulty have you experienced in using numbers generally in your everyday life?
   None ....
   A small amount......
   A moderate amount...
   A great deal ....

10. How much have you used numbers in work situations (including housework)?
    Question not applicable ....
    Not at all..........
    A small amount......
    A moderate amount...
    A great deal........

11. Would it have been useful to use numbers in your work more than you did?
    Question not applicable ....
    No, not at all.........
    Yes, a small amount....
    Yes, a moderate "......
    Yes, a great deal......

12. How much difficulty have you experienced in using numbers in work situations (including housework)?

None................
A small amount......
A moderate amount...
A great deal........

13. Qualifications you have in Maths? A level........ O level..... CSE
None..... Other.......(PLEASE SPECIFY) ....

14. How much difficulty have you experienced in Maths courses generally before attending the Polytechnic? i.e. at school or F.E. college?

None...............
A small amount.....
A moderate amount...
A great deal........
(PLEASE TICK ONE)

15. How would you rate yourself <u>now</u> in each of the following areas? (PLEASE CIRCLE THE MOST APPROPRIATE LETTER IN EACH CASE)

A = Very capable B = Fairly capable C = Not very capable
D = Not at all capable

i	BASIC OPERATIONS (+,-,x, ÷) ON WHOLE NUMBERS	A	B	C	D
ii	FRACTIONS	A	B	C	D
iii	PERCENTAGES	A	B	C	D
iv	DECIMALS	A	B	C	D
v	BASIC ALGEBRA	A	B	C	D
vi	GRAPHS	A	B	C	D

16. How much do you expect to use Maths, and/or numbers generally, in your studies at the Polytechnic?

None................
A small amount......
A moderate amount...
A great deal........

17. How much difficulty do you expect to have with Maths and/or with using numbers generally, in your studies at the Polytechnic?

Question not applicable
....
None ....
A small amount......
A moderate amount...
A great deal ....

18. Is there anything special you would like to learn about Maths or about using numbers during this year of study?...................
....
....

PLEASE DO NOT GO ON TO THE NEXT PART, UNTIL WE ASK YOU TO DO SO.

Performance Scale

This scale is a measure of how people cope with numerical problems when they have to answer them under test conditions. It is NOT a test of underlying mathematical ability or potential. You should not expect to complete all of the items on this scale. Please attempt the items in the order they are presented and do not skip an item unless you feel 'stuck'.

You may use any blank spaces on this sheet for calculations.

1. How much would it cost you altogether to buy a cup of coffee at 17p and a sandwich at 24p?

   ANSWER......................

2. How much does it cost to buy eight 14p stamps?

   ANSWER......................

3. Which is bigger (a) three hundred thousand or (b) a quarter of a million?

   ANSWER......................

4. If you buy five Xmas cards for 65p, how much is each card costing you?

   ANSWER......................

5. If you bought a raincoat in the 'summer sales' reduced from £44 to £29.50, how much would you save?

   ANSWER....................

6. 25% OFF
   ALL MARKED PRICES

   If you saw this sign in a shop, would expect to pay:
   (a) a half, or
   (b) three quarters, or
   (c) a quarter, or
   (d) a third
   of the original price?

   ANSWER ....

7. 27 + 33 = ...

8. 56 - 23.5 =......

9. 91 ÷ 7 = ...

10. 13 x 9 = ...

11. If Z = 4 then Z + 7 = ...

12. If Z = 3 then 9Z = ...

13. If 4Y = 16, then Y = ...

14. Suppose the rate of inflation had dropped from 10% to 6% which one of these results would you have expected:

    (a) Prices would have gone down, <u>or</u>
    (b) Prices would have stayed the same, <u>or</u>
    (c) Prices would still be rising but not as fast as before, <u>or</u>
    (d) Prices ought to have gone down but didn't.

    ANSWER................

15. Which of the following numbers is the greatest (a) 0.76 (b) 0.768 (c) 0.08. ANSWER............................

16. 13.8 - 0.73 + 5.9 = ...

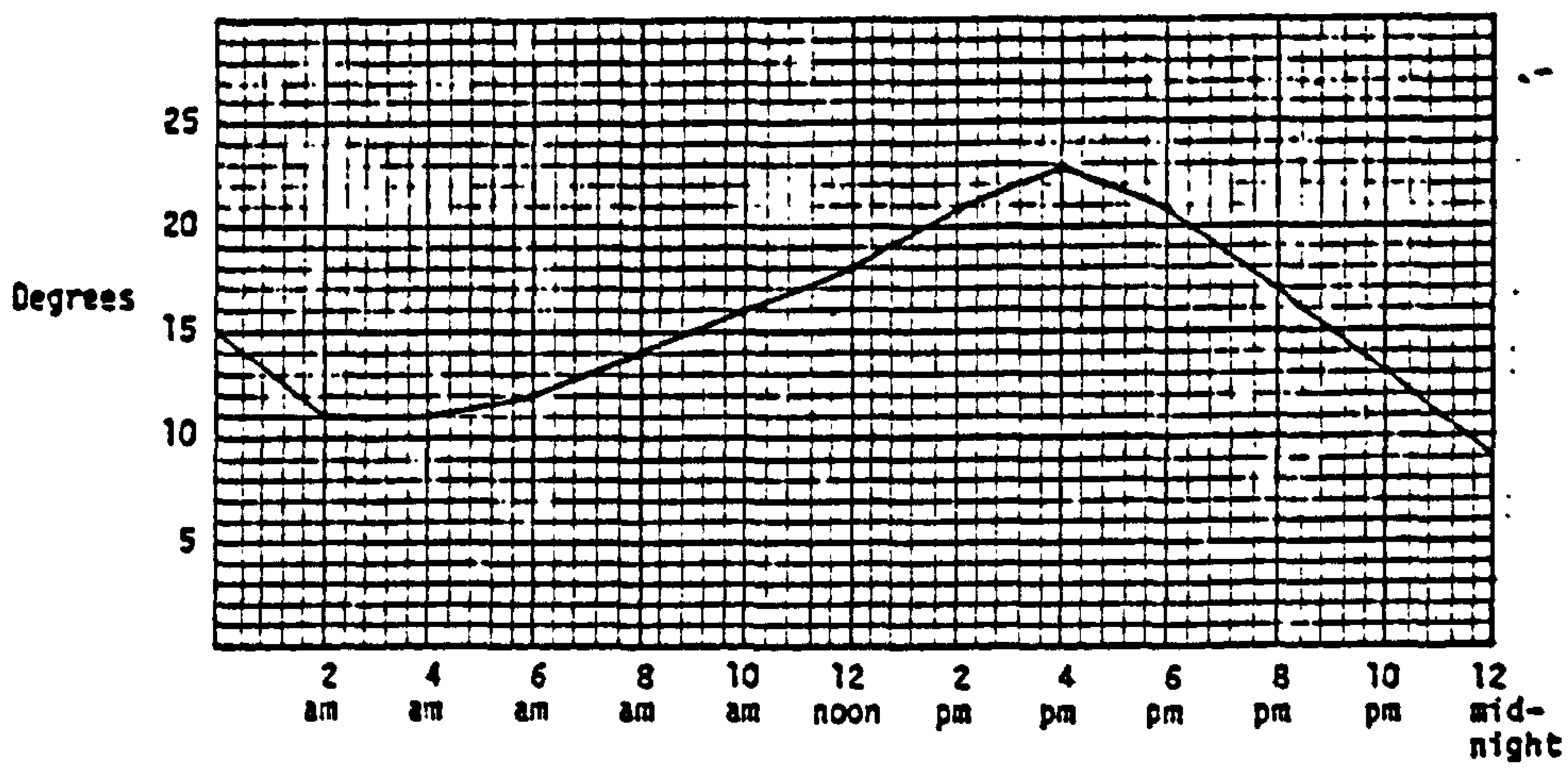
17. The ages (in years) of five people in a group are 18, 20, 22, 25, 30. What is the average age of the group ?

ANSWER......................

18. Suppose you go to a restaurant and the bill comes to a total of £3.72p. If you wanted to leave a 10% tip, how much would the tip be?

ANSWER ....

19. This shows how the temperature changed during a hot day last summer.



What was the hottest time of day? ANSWER.................

20. How hot was it at the hottest time of day? ANSWER..........

21. In an opinion poll for a by-election where there were two candiates 44% of those polled said they would vote for Jones, 34% said they would vote for Smith, the rest said they did not know. What percentage said they did not know?

ANSWER.................

22. Whom would you expect to win ?

ANSWER.................

23. How certain do you think this prediction is?

(a) totally certain (b) fairly certain (c) not very certain (d) not at all certain.

ANSWER.................

WHY?...
....

24. If the "don't knows" are excluded, what are the percentages of the <u>remaining</u> voters (i.e. of those who <u>have</u> expressed a preference) who say they will vote for the two candidates?

(a) Jones.......

(b) Smith.......

Middlesex Polytechnic

Situational Attitude Scale

For each of the following items please indicate to what extent you would generally feel either relaxed or anxious in the situations they describe. Please rate the situations according to your immediate feelings, on the following scale:

1. I would be very relaxed.
2. I would be relaxed.
3. I would be fairly relaxed.
4. I would be neither relaxed nor anxious.
5. I would be a little anxious.
6. I would be moderately anxious.
7. I would be very anxious.

PLEASE WRITE THE APPROPRIATE NUMBER IN FOR EACH QUESTION

	1 Very Relaxed 2 Relaxed 3 Fairly Relaxed 4 Neither Relaxed Nor Anxious 5 A Little Anxious 6 Moderately Anxious 7 Very Anxious
1. Determining the amount of change you should get from a purchase involving several items.	
2. Asking a stranger which bus to catch in a strange town.	
3. Enrolling for a course which includes a compulsory mathematics component.	
4. Buying a recommended mathematics textbook.	
5. Calculating which is the cheapest method of getting somewhere by public transport.	
6. Dividing a five digit number by a two digit number in private with pencil and paper.	
7. Finding a street in an A to Z street atlas.	
8. Walking into a room before a maths class starts.	
9. Listening to another student explain a maths formula.	
10. Having someone watch you as you total up a column of figures.	
11. Adding up 976 +777 on paper.	
12. Asking someone to do you a favour.	
13. Listening to a lecture in a maths class.	
14. Totalling up a restaurant bill where you think you are being overcharged.	
15. Walking into school or college and thinking about a maths course.	

	1 Very Relaxed	2 Relaxed	3 Fairly Relaxed	4 Neither	5 A Little Anxious	6 Moderately Anxious	7 Very Anxious
16. Choosing an item of clothing.							
17. Reading your P60 (or other statement) showing your annual earnings and taxes.							
18. Being asked a question by the teacher in a maths class.							
19. Being responsible for keeping track of the amount of subscriptions collected for an organisation.							
20. Sitting in a mathematics class and waiting for the teacher to arrive.							
21. Deciding which film to go and see by yourself.							
22. Reading a cash register receipt after you have bought something.							
23. Raising your hand in a maths class to ask a question.							
24. Figuring out V.A.T. at 15% on a purchase which costs more than one pound.							
25. Taking an examination for a maths course.							
26. Climbing a ladder.							
27. Working out a concrete, EVERYDAY APPLICATION, of mathematics that has meaning to you; e.g. calculating how much you can spend on leasure activities after paying other bills.							
28. Realising that you have to do a certain number of maths classes in order to complete your degree.							
29. Raising your hand to ask a question in an English class.							
30. Being given a set of numerical problems involving addition to solve on paper.							
31. Getting the result of a maths diagnostic test.							
32. Being asked a question by the teacher in an English class.							
33. Working out your monthly budget.							
34. Getting the result of an English diagnostic test.							
35. Completing a surprise maths quiz.							
36. Talking in a group of strangers (people from a similar social background to yourself, but unknown to you).							
37. Doing this questionaire.							

APPENDIX Q4 Questionnaire Design, Indicators and Coding

Here I discuss the questions for each category of variable.

(a) Social variables

The gender question was straightforward. Age at entry (as at 1st Sept.) was asked for (and coded) in years. For most age analyses, however, the students were divided into three groups: 18-20, 21-24, and 25+. This breakdown has been used in much research on mature students: the divisions relate to the point at which a student is considered to be "mature" for admission purposes (21+), and to that where he/she is considered self-sufficient for grant purposes (25+). Qualification in mathematics was measured by asking about mathematics exams passed (level and type; see sec. 4.1.2). (see NOTE 4, ch.4)

Following the discussion in sec. 2.3.2, three questions on social class were included, in the 1985 survey only. The first, on the student's most recent occupation (if any), was modelled on the question on occupation used in the 1981 census. The father's and mother's occupations were asked, for the time of the student's entry to secondary school, as this was considered as a "formative" period in the development of affect and performance in mathematics. All three questions were coded into the Registrar General's six categories, using the CODOT classification (OPCS, 1980).

Once this initial coding was completed, three further issues were relevant:
(i) whether to aggregate the indicators for father's and mother's occupation into one for parental social class, and how to do so;
(ii) whether to aggregate the indicator for parental occupation with the indicator for own occupation at the adult stage; and
(111) whether to collapse the six occupational categories for all three indicators, and how to do so (e.g. using "non-manual" and "manual").
These questions will be discussed along with the results on social class; see Sec. 5.6.

(b) Performance variables

For numeracy / practical maths (PM), I started with 10 questions of the ACACE / Gallup adult numeracy survey; see APPENDIX P1. Qu. 6 on reading the rail timetable was omitted, on the grounds that it would take up too much space on the questionnaire, and it might perhaps appear too elementary for a questionnaire circulated to students in higher education; Qu. 9 on reading a temperature graph was split into two questions, which became Qus. 19 and 20 on the "Poly" performance scale. All questions from ACACE were considered to be "practical", in the sense of relating to a specified context (briefly described within the question), with one exception: Qu. 4 (Qu.3 on the Poly scale) about comparing the size of two large numbers was considered as "abstract" (or SM).

Further questions considered as SM were produced as follows:
(i) Qu. 3 (ACACE Qu. 4) was parallelled by an additional SM item, Qu. 15 (see NOTE 9a, Ch.4), on indicating the largest of three decimal fractions (0.76, 0.768, 0.08, chosen so as to provide three "plausible" responses);
(ii) Qus. 1, 5, 2 and 4 (ACACE Qus. 1, 8, 2 and 5) relating to the "practical" use of +, -, X, and division respectively, were parallelled by eight "abstract" questions: Qus. 7, 8, 10 and 9 using the same four operations with whole numbers; Qus. 11, 12 and 13 using algebra; and Qu. 16 requiring decimal addition and subtraction.

Further questions considered as PM were produced as follows:
(iii) Qu. 18 (ACACE Qu. 3) on calculating a 10% tip and Qu. 6 (ACACE Qu. 10) on converting a percentage to a fraction were supplemented by two practical questions, Qu.21 involving operations on percentages , and Qu. 24 (the final one) involving a conversion of fractions to percentages (made much more difficult in an attempt at reducing "ceiling effects" in the PM score);
(iv) Qu. 14 (ACACE Qu. 7) on a critical understanding of the concept of "inflation", relating to official statistical information, was supplemented by an apparently "practical" Qu. 17 on calculating an average age, and Qus. 22 and 23 on the interpretation of opinion polling statistics. (see NOTE 9a, Ch.4)
For a full list of all the questions used, see the Performance Scale in any of APPENDICES Q1 to Q3.

The practical maths questions can be classified not only by the mathematical topics represented, but also by the practical context specified. The practical activities represented by these items are:
- spending money: Qus. 1, 2, 4, 5 and 6;
- tipping after eating in a restaurant: Qu. 18;
- interpreting opinion poll results: Qus. 21 and 24 (plus 22 and 23);
- interpreting a concept (inflation) from official statistics: Qu. 14;
- reading a graph of daily temperatures: Qus. 19 and 20; and
- summarising the ages of a group: Qu. 17.

In a study focussing on differences in performance, it is important that the questions used as do not give an advantage to either gender, or to any social class or age group. Though it is of course difficult to make comparisons of "familiarity" of activities across groups, what can be said is that the two contexts used most in my PM scale, money matters and results of political opinion polls, were chosen so as to avoid this problem, as much as possible.

Thus, I finished up with 10 abstract or "school maths" questions (1 from ACACE), and 12 practical questions (of which 9 were from ACACE), leaving aside Qus. 22 and 23. (Neither of the latter was included in the PM total score, as they required the exercise of judgement, and the explication of it, that might have been difficult for respondents to produce, especially towards the end of a timed set of self-response items.) The number correct on each of these subscales formed indices of performance on abstract or "school maths" items (PERFS), and performance on practical items (PERFP), respectively. For comparisons with the results of the ACACE / Gallup survey, I also formed an index of performance on those (ten) items that had also been used in that survey (PERFA). See APPENDIX R2 for a summary.

Certain changes were incorporated in the Performance Scale for the 1984 and 1985 versions; see APPENDIX Q8.

(c) Mathematics anxiety variables

The Situational Attitude Scale (SAS) was originally produced by Peter Sneddon and other colleagues in the School of Psychology (see Sneddon, 1982), for use in a small-scale survey in the autumn of 1982. For their study, they began with the set of MARS questions reproduced in Rounds and Hendel (1980) - 19 "numerical anxiety" (NA) items and 20 "maths test anxiety " (TA) items; for the 1972 version of the MARS, see APPENDIX P4. A number of changes were then made:
(i) elimination of items relevant only to the U.S. college situation, e.g. determining the grade-point average...(MARS no. 18);
(ii) "trans-culturation" of in the language of items, e.g. changing "math" to "maths", and changing "the W-2 earnings form" (U.S.) to "P60" (U.K.) (MARS no. 33);
(iii) elimination of items likely to be unfamiliar to the majority of Polytechnic students, e.g. hearing friends make bets on a game as they quote the odds (MARS no. 59).
After the completion of their study, a further change was made:
(iv) elimination of repetitive items, e.g. thinking about an upcoming maths test 1 week before, ...1 day before, ...1 hour before,... 5 minutes before (MARS Nos. 73 - 76).
This left 12 TA items and 12 NA items. One further item was constructed by Sneddon et al., for each dimension, and 10 items to measure general anxiety; see APPENDIX Q9.

Thus the version of the SAS used in this research included 13 numerical anxiety (NA) items and 13 maths test anxiety (TA) items plus 10 general anxiety (GA) items (all constructed), and one "state anxiety" item (constructed); see APPENDIX Q9.

The constructed numerical anxiety item focussed on an activity which many students were considered likely to engage in: "calculating ...the cheapest method of ...public transport". The new maths test anxiety item ("being asked a question by the teacher in a maths class") was constructed to form a pair with SAS No.23: "raising your hand in an maths class to ask a question".

For the general anxiety items, first of all, SAS nos. 29, 32 and 34 were exact parallels, in the context of academic English courses, of SAS nos. 18, 23 and 31, which were in the context of academic maths courses. The remaining items referred to situations which are generally experienced as anxiety-provoking, or the focus of phobias. Two items were about interacting with strangers, and a third was about asking an (unspecified) someone for a favour. Two more were about choosing or deciding, and there were individual items about finding a street in an atlas, and climbing a ladder.

I constructed the final item in the scale, SAS no.37, as a "state" anxiety item; the experience it asked the respondent to rate, in terms of how anxious or relaxed (s)he would feel, was "doing this questionnaire".

Besides the changes of wording, there was another way that the maths anxiety questions on the Polytechnic Situational Attitude Scale differed from the MARS - in the scale of responses offered. The MARS asked about: "things and experiences that may cause fear or apprehension ... how much you are frightened by it nowadays", and recorded responses on a 5-point scale :
1 = not at all
2 = a little
3 = a fair amount
4 = much
5 = very much.

The SAS question asked "to what extent you would generally feel either relaxed or anxious in (these) situations ...?" After some discussion, we decided to use a "symmetrical" scale, with responses on a 7-point scale :
1 = very relaxed
2 = relaxed
3 = fairly relaxed
4 = neither relaxed nor anxious
5 = a little anxious
6 = moderately anxious
7 = very anxious.

The reasons for these decisions were as follows. We were convinced that a symmetrical scale was easier for the respondent to grasp; see also the discussion in sec. 3.3.1. (The slight asymmetry in the wording of the responses for scale-points 2 and 6 was thought necessary, given the conventional usage of the two main affective terms, but not likely to vitiate seriously the validity of the scale, given that the numbers were also available as an additional cue.) There was also another, "ideological", reason for offering a symmetrical scale, including several degrees of positive response: we did not wish to reinforce the idea that feelings about maths might be mainly negative.

We offered 7 response categories because we wished to allow for a range of anxious and "non-anxious" responses and to counteract any tendency respondents might have to avoid the extreme responses "1" and "5" on a 5-point scale (for social desirability reasons). Though there was some concern that 7 categories might be too much for the respondent to cope with, this did not emerge as a problem in the pilot trials of the questionnaire (see sec.4.3.1).

The only change made to the SAS from 1983 was that in 1985 the instruction was added: "PLEASE WRITE THE APPROPRIATE NUMBER IN FOR EACH QUESTION." This was to discourage responses in the form of "tick-marks", which had sometimes been difficult to interpret precisely.

(d) Affective variables

First, confidence. Fennema and Sherman (1976) had intended their Confidence in Learning Mathematics Scale to measure "confidence in one's ability to learn and to perform well on mathematical tasks". Thus, my main question on confidence asked respondents to "rate yourself" ("assess your own skill" in the 1983 version) in each of six areas of basic maths or numeracy in the NO sense): basic operations, fractions, percentages, decimals, basic algebra, graphs; this was to be done by choosing one of four levels of "capability". An overall index of confidence was calculated by averaging the self-ratings of capability over the six areas. There was an additional indicator which was parallel in form to the "difficulty" items (see below), concerning how much difficulty the respondent expected to have with maths ("and / or with using numbers" added in 1985) "in your studies at the Polytechnic". These might be called the "self-rating" and the "Poly expectations" measures of confidence, respectively.

The usefulness questions (used from 1984 onwards) took account of the fact that respondents were adults experienced in and familiar with a range of activities. It therefore asked them to rate (on a 4-point asymmetrical scale) how much they had actually used numbers in "everyday life" and in "work situations (including housework)", and (in 1985 only) how much they expected to use "maths and / or numbers ... at the Polytechnic". Again, a rating of difficulty actually experienced with maths was asked for - in everyday life, in work (from 1984), and in maths courses generally. Two examples of what was considered as "everyday life" were given - namely, checking change, and measuring a room for buying paint - in order to clarify the meaning of these questions. The three-way division of contexts for usefulness and difficulty items was based on distinctions made in sec.2.1.2.

Finally, interest in maths. A satisfactory wording of this question turned out to be difficult to arrive at. In the first (1983) version, it asked whether there was "anything special you would like to learn in Maths" in Phase I (BASS) or in QM100 (DHE). The following year, this was broadened by adding "or during your studies generally" - but it was then realised that the wording of the question was slightly confusing for the DHE CM100 (control group) students who were not taking QM100. The wording was improved in 1985, but the early difficulties with it led me to judge it likely to be invalid. For this reason, the responses on interest were not included in the analysis.

For a detailed summary of the changes in wording to the confidence, usefulness and difficulty items over the three years of the survey, see APPENDIX Q7.

APPENDIX Q5 Introductory Script for Administering of Questionnaires, 1983 and 1984 (*)

(a) For DipHE QM100 [and CM100]

My name is Jeff Evans, and I teach on the BA Social Science at Enfield [and on DipHE this semester on ST100]. I am not involved in teaching QM100 or QM101.

I have here a questionnaire which I would like to ask you to fill out. The idea for this questionnaire arose because several of us teaching in the Polytechnic felt that in order to teach maths, and QM, better, we needed to know more about the experiences, skills and feeling around maths that people entering our courses have.

[I would like to tell you how the results will be used.] It is very important that the results of this will affect your position on the course in no way whatsoever! The way we do this is to make your questionnaire responses anonymous. When you hand in your questionnaire, I [or my research asistant] will put a number on the second page of the questionnaire [and take off the top sheet with your name and number]. The top sheet with your name and number will be stored separately, and will only be used if I want to contact you to ask you for an interview - to which you can of course say yes or no - or if we give another questionnaire later in the course, to link up the responses on the two.

The results for the group as a whole will be used in helping this year's courses to work better, and for further studies by several members of staff aimed at making maths less painful for students in general.

[Explanation of three parts of questionnaire]

(b) For BASS

(Introduced by PS, with variations: relating to theories of anxiety, and stress on the possibility of there being insufficient time to complete the entire Performance Scale.)

Note: * Changes for 1984 are shown in square brackets.

APPENDIX Q6 Introductory Script for Administering of Questionnaires, 1985

My name is Jeff Evans - I teach on the Social Science degree at Enfield, and on the DipHE.

I have a questionnaire which I would like to ask you to fill out. Why are we doing this? The aim of this is to help us to know more about the experiences around numbers of people entering our courses at the Polytechnic, and their skills and feelings in this area. How the will the results be used? They will be used to help this year's and future courses work better, e.g. as illustrative material in lectures where appropriate, and as part of some ongoing studies by several members of staff aimed at making maths less painful for students in general.

Will what you write affect you at all? No, the results of the questionnaire will not affect your position on the course in any way whatsoever. How can I guarantee this? By anonymising your questionnaire. When you hand in the questionnaire, I or my research asistant will put a randomly chosen number on the second page of the questionnaire - and take off the top sheet with your name, and that number, on it. The top sheet will be stored separately, and will be used only if I want to contact you to ask you for an interview - to which you can of course say yes or no - or, if we give another questionnaire later in the course, to link up the responses on the two.

The questionnaire will take about 20 minutes to complete and has three parts. First, the Experience Scale asks some questions about yourself and your experiences with numbers. Second, the Performance Scale gives you some numerical items to try. Here I'll ask everyone to take exactly the same amount of time so that the results are comparable with each other. You may well find that there is not enough time to do all the items, but dont't worry: remember that the results will not have your name on them. And if there are any questions that you want to discuss afterwards, I'd be happy to talk with you - and I'll leave a copy of the questionnaire with [the lecturer for this course]. Finally, the Situational Attitude Scale gives you the chance to say something about your feelings in this area. You can have as much time as you want for this final part and for the Experience Scale, i.e. the first part. So please start now, and stop when you get to the end of the first part.

APPENDIX Q7 The Experience Scale: Changes in Affective Items between 1983 and 1985

This table shows the changes of wording of the confidence, usefulness, and difficulty questions in the Experience Scale of the questionnaire (itself called the "Maths Experience Scale" in 1983), from 1983 to 1985.

Variable / Question	1983	1984	1985
Confidence / self-rating:			
"... assess your own skill..."	Qu.8		
"How would you rate yourself now...?"		Qu.10	
"How would you rate yourself now ..?"			Qu.15
Confidence / Poly expectations:			
"difficulty... you expect... with Maths in... studies at the Polytechnic"	Qu.7	Qu.11	
"difficulty... you expect... with Maths and/or with using numbers generally, in ... studies at the Polytechnic?"			Qu.17
Usefulness in everyday contexts:			
"how much ... you use numbers generally in your everyday life?"	--	Qu.4	
"how much ... you use numbers generally in your everyday life, e.g. ..."			Qu.8
Usefulness in work contexts:			
"how much ... used numbers in work situations (incl. housework)?"	--	Qu.6	Qu.10
Difficulty in everyday contexts:			
"difficulty... using Maths generally in your everyday life, e.g. ..."	Qu.6		
"difficulty ... using numbers generally in your everyday life, e.g. ..."		Qu.5	
"difficulty ... using numbers generally in your everyday life?"			Qu.9
Difficulty in work contexts:			
"difficulty ... using numbers in work situations (incl. housework)?"	--	Qu.7	Qu.11
Difficulty in school contexts:			
"difficulty ... in Maths courses generally..."	Qu.5	Qu.9	Qu.14

APPENDIX Q8 The Performance Scale: Changes in Items between 1983 and 1985

Qu.8	124 + 56 - 73 = ... Changed (1985) to: 56 - 23.5 = ... Aim: to make it more "parallel" to Qu.5 (savings on reduction from £44 to £29.50)
Qu.9	91 (divided by) 7 = ... Typed erroneously (1984) as: 91 - 7 = .. Corrected (1985).
Qus.11 to 13	Change "X" (unknown) to "Z" (1984). Aim: to avoid confusion with "x" (times) in Qu.10.
Qu.13	If 4Y = 68, then Y = . Changed (1984) to: If 4Y = 16, then Y = . Aim: to make it a test of algebraic understanding, rather than arithmetic.
Qu.14	"... inflation dropped from 20% to 15% ..." Changed (1984) to: "... inflation dropped from 10% to 6% ..." Aim: to make it more realistic in terms of 1980s levels.
Qu.21	"44% for Jones; 22% Don't Know; how many for Smith?" Changed (1984) to "44% for Jones; 34% for Smith; how many Don't Know?" Aim: to make it a more realistic problem.
Qu.23	"How confident are you about this prediction?" Changed (1984) to: "How certain do you think this prediction is?" Aim: to invite a more "objective" response based on reasons why.
Qu.24	Smith and Jones listed in opposite order to Qu.21. Changed (1985) to: same order as in Qu.21.. Aim: to avoid its being "tricky".

APPENDIX Q9 The Situational Attitude Scale (SAS): Origins of Items (MARS-based Maths Anxiety and General Anxiety)

SAS No.	MARS	Wording of 13 Numerical Anxiety (NA) Items
1	1	determining the amount of change you should get from a purchase involving several items
5	(C)	calculating...cheapest method of...public transport
6	6	dividing a five digit number by a two digit in private with pencil and paper
10	2	having someone watch...you total up a column of figures
11	14	adding up 976 + 777 on paper
14	10	totalling up a restaurant bill where you think you are being overcharged
17	33	reading your P60...showing...annual earnings and taxes
19	87	being responsible for keeping track of the amount of subs. collected for an organisation
22	47	reading a cash register receipt after you have bought something
24	48	figuring out VAT at 15% on a purchase which costs more than one pound
27	65	working out a concrete, EVERYDAY APPLICATION, of mathematics that has meaning to you; e.g. calculating how much you can spend on leisure activities...
30	67	being given a set of numerical problems involving addition to solve on paper
33	90	working out your monthly budget

SAS No.	MARS	Wording of 13 Maths Test Anxiety (TA) Items
3	26	enrolling for a course which includes a complusory mathematics component
4	23	buying a recommended mathematics textbook
8	28	walking into a room before a maths class starts
9	27	listening to another student explain a maths formula
13	89	listening to a lecture in a maths class
15	36	walking into school or college thinking about a maths course
18	(C)	being asked a question by a teacher in a maths class
20	39	sitting in a mathematics class and waiting for the teacher to arrive
23	45	raising your hand in a maths class to ask a question
25	54	taking an examination for a maths course
28	81	realising that you have to do a certain number of maths classes in order to complete your degree
31	53	getting the result of a maths diagnostic test
35	91	completing a surprise maths quiz

Note: (C) = constructed

(... cont'd)

APPENDIX Q9 (cont'd)

SAS No.	Wording of 10 constructed General Anxiety (GA) Items
2	asking a stranger which bus to catch in a strange town
36	talking in a group of strangers...
7	finding a steet in an A to Z atlas
12	asking someone to do you a favour
16	choosing an item of clothing
21	deciding which film to go and see by yourself
26	climbing a ladder
29	raising your hand to ask a question in English class
32	being asked a question by the teacher in English class
34	getting the result of an English diagnostic test

APPENDIX R1 Codebook for Questionnaire Items, for Sample BASS 1985

General Notes: 1. Missing value (e.g. no resp.) = 9 normally
2. For the wording of the questions, see APPENDIX Q3.

(a) Experience Scale

No.	Variable	Codes Used
--	SAMPLE	5 (6/7) = B85 (C85/D85)
--	ID (anon.)	001 to 200
1	I1 to I3 (expressed interest in study of Track)	0/1 = Econ./Psych. 2/3 = Planning/Soc. Pol. 4/5 = Soc. Work/Sociol.
	Note: If no mention, code 1st column (of 3) = 9 Code up to 3, in ascending order; otherwise = blank	
2	AGE (years)	18 to 98; 99 = No Resp.
3	SEX	0 = Male; 1 = Female
4	SCS (own recent occup.)	1 to 6 = RG Class I to V, FT [3/4 = RG III NM / III Manual] 7/8 = PT NM / PT M; 9 =NR; 0 = "None to date"
5	SCF (father's occup.)	(1 to 6 - as above
6	SCM (mother's occup.)	(7=dead; 8=DK; 0= no pd. work
7	HLANG (lang. at home)	0 = English; 1 = other
13	QUAL (Maths exams passed)	0=none; 1=CSE; 2=O-level/equiv 3=A-level/equiv; 4=other
8/10	USED / USWK (usefulness)	(0 = none
9/12	DFED / DFWK (difficulty)	(1 = a small amount
14	DFSM (diffic.)	(2 = a moderate amount
17	CONFEP (Exp. re Poly)	(3 = a great deal
15	dimensions of CONFSR	1=not at all capable 2=not very cap.; 3=fairly cap.; 4=very cap.
18	I4 ("anything would like to learn in Maths")	0 = no indication; 1= general 2 = specific

Note: 1. Qus. 11 and 16 not coded.

(b) Performance Scale

Notes: 1. Correct answer normally = 0, approximate = 1, incorrect = 2, and particular characteristic errors = 3, ...
2. Since "approximately correct" answers were not used in the analysis, their codings are not included here.

No.	Correct	Characteristic Errors
1	41p	
2	£1.12	
3	three hundred thousand	"the same"
4	13p	£3.25
5	£14.50	33%
6	three quarters	a quarter
7	60	
8	32.5	
9	13	

Performance Scale (cont'd)

No.	Correct	Characteristic Errors
10	117	
11	11	
12	27	93
13	4	64
14	"prices still rising, but not as fast"	"would have gone down" / "ought to have ... but didn't"
15	0.768	0.76 / 0.08
16	18.97	
17	23 yrs.	
18	37p OR 37 1/2p OR 38p	37.2p
19	4 pm	
20	23 degrees	
21	22%	
22	(Jones)	
23	(judged cogent)	
24	56%, 44%	

(c) Situational Attitude Scale

No.	Variable	Codes Used
...	N1 to N13 (num. anxiety)	(1 to 7, as precoded
...	T1 to T13 (m. test anx.)	(
...	G1 to G10 (gen. anxiety)	(
37	MA37 (state anxiety)	(

APPENDIX R2 The Performance Scale: Aggregation of Items into Performance Indices for School Maths (PERFS), Practical Maths (PERFP) and comparison with ACACE survey (PERFA)

Item no.	PERFS	PERFP	PERFA
1		*	*
2		*	*
3	*		*
4		*	*
5		*	*
6		*	*
7	*		
8	*		
9	*		
10	*		
11	*		
12	*		
13	*		
14		*	*
15	*		
16	*		
17		*	
18		*	*
19		*	*
20		*	*
21		*	
22		-	
23		-	
24		*	

APPENDIX R3 Glossary of Variables used in Statistical Analyses, including Scales and Categories used for Outcome and Predictor Variables in Regression Models

Variable	Dummy	Coding
PERFS (school maths performance)		no. of items scored correct out of 10 judged as abstract
PERFP (practical maths performance)		no. of items scored correct out of 12 judged practical
PERFA (performance on ACACE items)		no. of items scored correct out of 10
TA (maths test anxiety)		(7-point scale, ranging from
NA (numerical anxiety)		(1 = very relaxed through 4 =
GA (general anxiety)		(neither relaxed nor anxious;
(all avgd. over 13/10 items)		(to 7 = very anxious
QUAL (qualification in maths, in 2 categories)		= none or CSE; O-level or A-level (or equivalents)
SEX (gender)		= male; female
AGE2 (age in 2 categories)		= 18-20; 21+ years
AGE3 (age in 3 categories)		= 18-20; 21-24; 25+ years
2 dummy variables)	AGE2	= 18-20; 21+ years
set up for AGE3)	AGEQ	= 21-24 years; the rest
SCP (parents' occupational social class)		= working class; mixed; middle class
2 dummy variables)	SCP1	= the rest (working class and mixed); middle class
set up for SCP)	SCP2	= the rest (middle class and mixed); working class
SCS (student's own most recent full-time occupation)		= none to date; manual; non-manual
2 dummy variables)	SCS1	= the rest (manual and none to date); non-manual
set up for SCS)	SCS2	= the rest (middle class and mixed); working class
YEAR (year of entry to course)		= 1983; 1984; 1985
2 dummy variables)	YR1	= the rest; 1984
set up for YEAR)	YR2	= the rest; 1985
SAMPLE (course of study)		= BA Social Science; DHE Communic'n / DHE Quant. Methods Basic Modules
2 dummy variables)	SA1	= the rest; BASS
set up for SAMPLE)	SA2	= CM; the rest (BASS and QM)
CONFSR (confidence of self-rating; average of items on 6 areas of basic school maths)		1 = not at all capable; 2 = not very capable; 3 = fairly capable; 4 = very capable
DFSM (difficulty with previous maths courses)		(0 = none;
DFED (difficulty with numbers in everyday life)		(1 = a sm.
DFWK (difficulty with numbers in work)		(amount; 2 = a
USED (use of numbers in everyday life)		(moderate amount;
USWK (use of numbers in work)		(3 = a great deal

Note: For each dummy variable, the first-mentioned category was coded "0" and the second coded "1".

APPENDIX R4 The Performance Scale: Type of Item, Answer(s) Coded as Correct, Percentage Correct and Some "Characteristic Errors"

Item No.	Type	Correct Answer(s)	% Correct
1	PM / money / +, integers	41p	95
2	PM / money / x, integers	£1.12	89
3	SM(?) / choosing larger integer	three hundred thousand	81
4	PM / money / ÷, integers	13p	88
5	PM / money / -, integers & decimals	£14.50	87
6	PM / money / % to fraction	three quarters	64
	(Char. Error	a quarter	32)
7	SM / +, integers	60	98
8	SM / -, integers & decimals (1985)	32.5	78
	SM / - & +, integers (1983, 1984)	107	86
9	SM / ÷, integers (1983, 1985)	13	90
	SM / -, integers (1984)	84	96
10	SM / x, integers	117	91
11	SM / +, algebra	11	94
12	SM / x, algebra	27	88
13	SM / ÷, algebra (1984, 1985)	4	93
	(1983)	16	78
14	PM / inflation / interpretation	"still rising, but not as fast as before"	67
	(Char. Errors	"gone down"	21
		"ought to have gone down, but didn't"	8)
15	SM / choosing largest decimal	0.768	64
	(Char. Errors	0.76	23
		0.08	10)
16	SM / + & -, decimals	18.97	57
17	PM(?) / average (statistics)	23 yrs.	70
18	PM / money, tipping / calculating 10%	37p/ 37 1/2p/ 38p	64
	(Char. Error	37.2p	13)
19	PM(?) / graph reading	4 pm	93
20	PM(?) / graph reading	23 degrees	87
21	PM / opinion polls / -, %s	22%	82
22	- / opinion polls / interpretation	(Jones)	(84)
23	- / opinion polls / interpretation	(judged cogent)	(40)
24	PM / opinion polls / calculating %s	56%, 44%	4
	(Char. Error	no response	63)

APPENDIX R5 Profiles of the Samples

In this section, profiles of the Polytechnic samples are discussed for the basic variables of the study, including:
- the basic social variables:
  gender (called SEX),
  parents' social class (SCP, for 1985 samples only),
  student's own social class (SCS, for 1985 only),
  age (AGE) in years,
  qualification in maths (QUAL);
- the outcomes:
  performance in school maths (PERFS) out of 10 questions,
  performance in practical maths (PERFP) out of 12 questions,
  numerical anxiety (NA),
  maths test anxiety (TA),
  general anxiety (GA);
- intervening affective variables:
  confidence in terms of self-rating in maths (CONFSR),
  confidence in terms of expectations of (lack of) difficulty with maths / numbers at the Polytechnic (CONFEP),
  use of maths / numbers in everyday activities (USED),
  use of maths / numbers in work (USWK),
  difficulty with maths / numbers in everyday activities (DFED),
  difficulty with maths / numbers in work (DFWK),
  difficulty with earlier school / college maths courses (DFSM).

This information is summarised in a Glossary in APPENDIX R3. (For a description of the indicators used in each case, see sec. 4.2.2 and APPENDIX Q4.)

Tables 5.1(a), 5.1(b) and 5.1(c) show summaries of the relevant data for all samples from the 1983, 1984 and 1985 student entries, respectively. (see NOTE 1, Ch.5) In each year, there were samples from the BA Social Science (BASS) and the Diploma in Higher Education (DHE); the DHE samples included all those students taking QM100 (the Quantitative Methods Basic Module) in 1983, and those students taking both QM100 and CM100 (Communications Studies Basic Module) in 1984 and 1985. I shall discuss the profiles year by year, and course by course. The main aim here is to gain an initial feeling for the data, and to judge whether the eight samples are sufficiently similar to be pooled for the bulk of the analysis.

The three cohorts seem to have been increasingly better qualified over the period 1983 to 1985, with 41%, 43% and 52% respectively having passed O- or A-level maths (or an equivalent). There was a slightly higher proportion of women in the 1985 intakes, and average age over the three year remained about the same.

Social class data were produced in 1985 only; see sec. 4.2.2 for discussion of SCP (parental social class) and SCS (student's own social class). Here there do not seem to have been great differences between courses; the most substantial appears to be the relatively high proportion (45%) of CM students that held full-time non-manual jobs before entering the Polytechnic. According to the hypotheses on social class (see sec. 4.1.3), this might be expected to provide an advantage in PERFP, and the CM 1985 subsample does indeed score highest on this measure (9.2 questions correct out of 12, as compared with the overall average of 8.9 questions).

For performance differences across courses, no course group averages more than 2/5 of a question correct (or 1/4 of a standard deviation) above or below the overall mean of 8.4 questions correct out of 10 (see the final column of Table 5.1(a)) - with the exception of the 1985 QM group which scored slightly below this band on PERFS (7.8 questions correct out of 10); part of the explanation may be this sample's relatively low maths qualifications and higher average age.

When we consider the anxiety variables, it should be noted that the variables used here are average scores for the numerical anxiety (NA) and the maths test anxiety (TA) scales (13 questions each), and for the general anxiety scale (10 questions) constructed especially for this study (see sec. 4.2.2 and APPENDIX Q9). The average score for NA was around point 3 on the scale (meant to indicate "fairly relaxed" - see APPENDIX Q1), and, for TA, it was just over scale point 4 (the neutral point: "neither relaxed nor anxious"). General anxiety (GA) also averaged about point 3 on the 7-point scale. Again, no sample mean was more than 1/4 of a standard deviation above or below the overall mean.

When we consider scores on affective variables, we find that there were no substantial differences, across the eight samples, in confidence as measured by the student's self-rating averaged across six areas of school maths (CONFSR). In this case, the averages are all around 2.8, an average self-rating of somewhat closer to "fairly capable" than to "not very capable" - a moderately confident response. However, for confidence as measured by expectations of difficulty "with Maths (see NOTE 2, Ch.5) in your studies at the Polytechnic" (CONFEP), we note immediately the exceptionally low (i.e. more "confident") average responses for the two CM groups. It is not difficult to explain this: the CM groups expected less difficulty with Maths at the Polytechnic because a high proportion of them were not expecting to study Maths at all - unlike the QM and BASS groups who had chosen, or had been required, to do so. What this means for the study is that this question has a fundamentally different meaning for the CM group and for the other groups - and hence it is not possible to use the results for this question in ways that assume comparability of meaning across groups: for example, in comparing means, or in modelling.

The remaining affective variables - usefulness and difficulty - showed few interesting differences across samples. An interesting difference among variables was that the question about difficulties with earlier maths courses (DFSM) showed a much higher response, i.e. more reported difficulty, than did the questions about difficulty in using numbers in everyday life (DFED), or in work situations

(DFWK).

Several further conclusions are drawn in Sec. 5.1.

APPENDIX R6 Gender Differences in Performance and Affect

In order to examine the gender differences in SM and PM performance more fully than in Sec. 5.5, boxplots are shown in Figs. 5.2(a) and 5.2(b). Much the same picture is given of the different levels of performance by comparing medians, as in comparing means. However, a richer picture of the differing spreads of the male and female distributions is given by considering the quartiles, the extreme values and the "outliers", rather than simply the standard deviations. in the case of PERFS, the lack of symmetry of the quartiles about the median and the closeness of the 3rd quartile to the maximum score suggest that there were indeed "ceiling effects" for both men and women.

In addition to the gender differences in expresed maths test anxiety and numerical anxiety reported in Sec.5.5, there were similar differences for the measure of "state" maths anxiety, MA37. (Because this measure did not appear to add much to the picture provided by TA in particular, it was not included in any subsequent analysis.) There was no difference in the measure used in this study for general anxiety; nor was there any gender difference in the subset of three items designated as "English test anxiety".

The expectation for CONFSR, a self-rating in 6 topics of school maths (e.g. percentages, algebra, graphs) - that men would rate themselves more "confidently" - was confirmed ($p<.001$). For other affective factors, the difference in DFSM, difficulties with earlier maths courses, was in the expected direction, i.e. women reported having had more difficulty, but the difference was at most of borderline statistical significance. There had been no clear expectation about difficulties in using numbers / maths in everyday or work contexts, as measured by DFED and DFWK, but here again women actually reported having had more difficulty. Finally, for the use of numbers in everyday life and in work, USED and USWK, there was effectively no gender difference.

APPENDIX R7 Social Class Differences in Performance and Affect

In the discussion of measurement and coding (APPENDIX Q4), three issues were posed to be taken up here:
(i) whether to collapse the indicators for social class from the original (Registrar General's) six-way categorisation of occupations, and how to do so;
(ii) whether to aggregate the indicators for father's and mother's occupations into one for family or "parental" occupational class, and how to do so; and
(iii) whether to aggregate the indicator for parental occupation, with the student's own occupation.

On (i), for each parents' occupation, the Registrar General's categories I, II and III-NM were collapsed together as "non-manual", and categories III-M, IV and V as "manual". This was in line with the current convention in social research, and was also done in order to ensure sufficiently large subgroups. For the student's own most recent full-time occupation (SCS) - if any, the categories used were: non-manual full-time (NM), manual full-time (MAN), and "no occupation to date". (see NOTE 12, Ch.5)

On (ii), two methods for aggregating the indicators for father's and mother's occupations into one for parental occupation (SCP) were considered. The first was "symmetrical", in that SCF and SCM had the same weight: parental occupation was considered middle class (MC), if both parents' occupations were non-manual, or if one parent was non-manual and the other was reported as not working, or had no occupation reported, at the time the student began secondary school; SCP was considered working class (WC), if both reported occupation(s) were instead manual, or if one parent was manual and the other was reported as not working, or had no occupation reported; and SCP was considered "mixed" if one parent was from each category. Thus the "mixed" parental occupation group in the first way of aggregating included students from three subgroups - potentially rather different:
"non-manual" fathers and "manual" mothers (using R.G.'s categories);
"manual" fathers and mothers in occupational categories I and II; and
"manual" fathers and mothers in occupational category III-NM. (The numbers included in these three subgroups were 11, 13 and 14 respectively.)

In the second way of aggregating, only the first two subgroups were considered as "mixed", while the third was aggregated with the WC group; this method was "asymmetrical" in this sense. In deciding between the two methods, it was noted, first of all, that only 14 of 291 in the 1985 sample (or about 5%) would be differently allocated, by the two. Second, the method of allocation used did not seem to make a great deal of difference to the comparison of means in Table 5.10. Therefore I decided to use the first "symmetrical" method of aggregation of father's and mother's occupation at this stage. (see NOTE 13, Ch.5)

On (iii), whether to aggregate the indicator for parental occupation at the secondary school stage, with the student's own occupation at the adult stage, we can consider the relationship between parental occupation (SCP) and student's own occupation (SCS) in Table 5.7. Focussing on the MC and WC values of SCP, and the NM and MAN values of SCSC, we notice that 35% of those reporting MC parental occupations (as specified above) themselves had NM jobs before college, but only 16% of those with WC parents had manual work. However, 51% of those with WC parents had "moved up" to their own NM job, while 28% of those from MC parents reported their last job as manual. This suggests a fair amount of what might loosely be called "intergenerational mobility", especially upward mobility, amongst this group of students - as was expected. However, Table 5.7 also suggests that any supposed advantages from having middle class parents and from having one's last job as non-manual, might have tended to work against one other, for many members of the 1985 sample; this should be kept in mind while considering the results below. It also indicates clearly that it would be misleading to aggregate the indicator for the parental occupation, with that for the student's own most recent job.

(a) Parental social class differences

I now turn to results relevant to the questions / hypotheses concerned with social class differences, relating first to parental occupation (SCP); see Table 5.8. Though there was little relevant research (see sec. 2.3.2), I expected generally that students with MC parents would be "advantaged" over those with WC parents - at least in outcomes to do with formal education, e.g. SM performance, maths test anxiety, confidence, and difficulty in SM.

First, the parental occupation differences in SM performance, PERFS, and practical maths performance, PERFP, were in the expected direction - i.e. students of middle class backgrounds scored higher than those from the working class - but neither difference was substantial: one fifth and one tenth of a question respectively. And they can be expected to decrease even further when qualification in maths and age are controlled for (see Ch. 6), since the MC group was younger and also better qualified in school maths.

However, for maths test anxiety (TA), numerical anxiety (NA) and general anxiety (GA), the parental occupation differences were in the opposite direction to that expected! The expected advantage in CONFSR for those with MC parents was not observed, nor was that for DFSM, difficulty in previous maths courses.

It is worth noting that the mixed group scored "worse" than both of the other two groups in general: they scored lower on the performance measures, and reported more of both types of maths anxiety and less confidence. However, as indicated above, this group, was an aggregation of three very small groups, that could each have had very different experiences of mathematics and the use of numbers - and hence it was difficult to investigate this potentially very interesting aspect of social class differences further in this particular study. (see NOTE 14, Ch.5)

In the discussion of hypotheses about gender differences (sec. 4.1.3(e)), it was recalled that some previous research had found greater social class differences in maths participation (number of courses taken) and in performance for females than for males. Table 5.9 gives the relevant results from the Polytechnic survey. For participation - or at least, for Maths qualification passed - the difference between men and women in terms of the advantage related to having MC, rather than WC, parents was small, as it was for practical maths performance and for confidence (in fact zero, for the latter). Only for school maths performance was there a substantially larger parental occupation difference between MC and WC for women than for men, and it was at most on the borderline of statistical significance, In fact what is most striking about Table 5.9 is the way that gender differences were generally much larger than parental occupation differences.

(b) Differences based on student's own occupation

Here I wondered whether those who had had non-manual jobs would have used numbers more in work before coming to the Polytechnic, and would therefore be advantaged in practical maths performance, numerical anxiety, and difficulties in using numbers previously in work. The results are given in Table 5.10.

For practical maths performance, PERFP, the difference between students whose last full-time work had been coded as non-manual (NM) and those with manual (MAN) work was in the opposite direction to that expected; i.e. it was in favour of those in the MAN category. The latter was also true for school maths performance, PERFS, though there had not been a clear expectation for that variable. When we consider anxiety variables it can be seen from Table 5.10 that differences in numerical anxiety, NA, and in maths test anxiety, TA, were not substantial, and again they were in the opposite direction to that expected in the case of NA. For use of "numbers in work situations (including housework)" (USWK), there was no difference between students in non-manual and manual groups, contrary to expectation. For difficulties with numbers in work situations (DFWK), the difference was in the opposite direction to that expected; that is, students coded as NM reported more difficulty than MAN students. (see NOTE 15, Ch.5)

APPENDIX R8 Age Differences in Performance and Affect

My hypotheses about age differences, discussed in sec. 4.1.2(g), were that younger students would perform better on school maths especially, and would report lower levels of maths anxiety (especially TA) and higher levels of confidence. However, I expected that older students might report greater use of numbers at work, and therefore might even surpass the younger students in practical maths performance. A summary of the hypotheses investigated, the observed values, and the (uncontrolled) differences, are given in Table 5.11, for three age groups: Younger (18-20), Intermediate (21-24) and Older (25+).

For the measures of performance, confidence and anxiety, the results were generally in the expected order of progression across the age groups. The main exception was that the PERFP (practical maths) mean for the intermediate age group (21-24 years) was lower, by about half a question, than those for either the younger (18-20) or the older (25+) groups. Thus the relationship between age and practical maths performance seemed to be quadratic, a sort of "upright U", with the intermediate age group scoring lowest. (Further analysis, using more age groups, yielded essentially similar results.) On PERFS (school maths performance), the results were not exactly as expected: the younger group was substantially superior - by about 3/4 of a question, or half a standard deviation, on average - to the other two age groups, whose scores were about the same.

Both of these results require further consideration. For PERFS, the differences in qualifications would be sufficient to explain at least part of the age-based differences, but not all: the older group did better relative to the intermediate group than we would expect on the basis of their qualifications alone. This confirms the need for modelling of all the influences on performance, as noted in the discussions of gender and social class differences.

The PERFP result was puzzling. Perhaps the intermediate group may have had the worst of both worlds: their memory of knowledge and skills from school maths may have "decayed", <u>and</u> they might as yet not have had sufficient experience with the use of numbers or "maths" at work for this to be evident in their PERFP results. If we check the proportions of the age groups who had held full-time jobs prior to coming to the Polytechnic, we find an expected progression - 43% / 70% / 74% - over the 18-20 / 21-24 / 25+ groups, with a similar progression in the proportion who held <u>non-manual</u> jobs - 20%, 45%, 54%; the fact that there was not much difference between the two older age groups means that differences in work experience, or differences in non-manual work experience, would not help much to explain the pattern of age differences observed in PERFP.

Further, when we consider USWK and USED, the reported use of numbers in work, and everyday, situations, there were no age differences; this was contrary to expectations that use and familiarity with numbers in non-school settings would increase with age and "experience". Of course, this result may mean simply that, as people get more experience in using numbers, say at work, they come to see this as "practical" and routine, and certainly as nothing to do with "maths".

Further light may be shed on this anomalous result for practical maths performance in the discussion of the modelling in Ch.6. What the analysis so far makes clear is the need to use three age groups, for the analysis of PERFP at least - though two age groups would seem to be sufficient for analysing PERFS.

For both dimensions of maths anxiety, the differences were in the expected direction. However, though they were statistically significant ($p<.05$), except for the difference on NA for the two older groups, they amounted only to 1/4 to 1/5 of a scale point for TA and to 1/6 to 1/10 of a scale point for NA. As hypothesised, the differences were greater (in terms of the number of standard deviations) for TA than for NA - at least for the two older groups. The differences for CONFSR, confident self-rating in school maths, were in the expected direction; they were statistically significant (p<.01), but, in substance, the largest difference (between younger and older groups) amounted only to 1/3 of one level of self-rating (i.e. 1/3 of the difference between an average rating of "fairly capable" and a rating between that and "not very capable", starting near the former level). As with gender, CONFSR produces results similar to maths test anxiety.

APPENDIX R9 Differences related to Maths Qualification in Performance and Affect

As argued earlier (Ch.4), qualification in school mathematics was the most appropriate indicator in this study for the variable focussed on in a number of earlier (especially American) studies, viz. number of maths courses taken (or "participation"). Here I expected it to be most strongly related to SM performance, TA and confidence. Table 5.12 shows the results for the main outcome variables separated into four levels of qualification in mathematics. These are more detailed than most of the analysis for this study which was done using only two categories of maths qualification: O-level and/or A-level, and others.

First, it is noteworthy that the students without any qualification at all were substantially older than the other three groups, and that the proportion of men in the groups increases with increasing qualification. For practical maths performance (PERFP), there were clear and substantial differences between those with O-level or A-level maths on the one hand, and those with CSE or no qualification on the other. However, for those measures more closely associated with school maths - SM performance (PERFS), maths test anxiety (TA) and self-rating on school maths (CONFSR) - there was a more hierarchical progression from the weakest scores for those with no qualification to the strongest for those with A-level, with all differences at least on the borderline of statistical significance (p<.05). The PERFS differences in particular were substantial - e.g. 2 questions out of 10 between those with no qualification and those with A-level.

For numerical anxiety (NA) and general anxiety (GA), there were no substantial differences. However, the fact that the students with A-level maths scored highest on GA, while scoring much the lowest on TA and NA, was notable: it is consistent with the idea that these students may have been managing some of their anxieties - but not all of them - by excelling in mathematics.

The results reported in this section confirmed the importance of the relationships of qualification in maths with the performance and anxiety / confidence variables. The analysis suggests that two categories of maths qualifications (O/A-level vs. others) would be sufficient for the modelling of PERFP and NA, whereas four groups might be better - other things being equal - for PERFS and TA.

APPENDIX R10 Other Relationships between Performance and Affect

Here results are presented which relate to relationships which have not so far been discussed; see the hypotheses discussed in subsection 4.1.2 (i).

(a) Relationships between performance and affective variables

If the measures for the affective variables, and particularly their grounding in context, are valid, then I would expect the correlations of PERFS with confidence, and with difficulty in previous maths courses, to be greater (numerically) that those of PERFP with the same two variables. Similarly, I would expect the correlations of PERFP with use of numbers in work and everyday contexts (USWK, USED), and with difficulty in the same two contexts (DFWK, DFED), to be greater (numerically) that those of PERFS with the same four variables. In Table 5.14, measures of the direction and strength of the relationships between the two performance measures, PERFS and PERFP, and the various affective variables, are presented as Pearson correlation coefficients, along with an indication of the original hypotheses.

All of the hypotheses about individual correlations were confirmed, with observed correlations which were impressive, using statistical significance as a criterion. However, using the strength of the correlation as a criterion, only about half of these are greater than .23 (r-squared > .05) - notably those that involved CONFSR, self-rating in school maths, DFED, difficulty in using numbers in everyday situations, and DFWK, difficulty in using numbers in work. However, it was only for CONFSR that the relative strengths of the correlations with PERFS and with PERFP were in the order predicted; this and the superior reliability of CONFSR (a scale based on six items) suggest that these correlations were the most dependable.

The expectations based on the method of dealing with performance-in-context and affect-in-context were less supported by the data here than were those involving performance and anxiety in Sec.5.7. This suggests either that there are problems of reliability and/or validity with the affective indicators, or that the relationships between affective and performance variables are less clear, or both. Nevertheless, all of these affective variables will be considered for inclusion in the models of performance discussed in Ch.6.

(b) Relationships among the affective variables

The remaining hypotheses of interest expected a negative relationship between USWK, use of numbers at work, and DFWK, difficulty in using numbers in work, and another between USED, use of numbers in everyday situations, and DFED, difficulty in using numbers in everyday life - through the intervening variable of <u>familiarity</u> (see sec. 4.1.3 (i)). However, the very low correlations between USED and DFED ($r = -.11$), and between USWK and DFWK ($r = -.04$) (see NOTE 16, Ch.5), suggests that there was little or no support from this data for the idea that "familiarity (from use) breeds content" - as opposed to difficulty.

Introduction

Hello ________, How are you today? (offer coffee or tea).
As you know, I am currently doing research on people's experience with numbers and on what sorts of things help people feel comfortable with numbers, and what stands in their way. This is part of my work as a research student at the Institute of Education. So what I would like to do in this interview is to give you some space to talk about your experiences with numbers, and your feelings about them.

Now it would help me a lot, if I could tape record the interview. Only I and my academic supervisors, and you, if you wish will listen to it. Is this all right with you?

Finally, let me just say that, in the same way as it was up to you whether you agreed to do this interview, you don't have to answer anything I ask you if you don't want to - All right? (/O.K.?)

First, may I ask you some questions about yourself?

0) What Track of the degree are you on? Is this the same as the one you came to do?

1) How old were you when you joined the course (1.9.85)?

2) Where did you study most recently?
How much did you use maths then, if at all?

3) What level of qualifications, if any, do you have in Maths?

4) What sort of paid work have you done most recently?
How much did/do use numbers there, if at all?

Now, I've tried several ways to let people get into talking about their experiences with numbers, and the best way seems to be giving you some questions to try. So I'd like to ask you if you would mind taking a look at a few questions here. And, for each questions, while you are looking at it. I'd like you to say:

First, what sorts of other things that you do these days, if any, it reminds you of;

Second I'd like you to tell me as well as you can about how your thinking about the question, and what your answer would be.

And, finally, I'll ask you what sorts of earlier experiences ('with numbers': dropped from 86/7 onwards) it reminds you of and feelings it brings up.

Now, during the time that we're doing the question, I'll just note what you're saying. But at the end, if you want to, we can take some time to discuss any of the questions you wish.

Introductions to Questions.

[1] (pie-chart) With this one, does it make you think of any other things you currently do?

[2] ("school" %) Fine, thank you, could you tell me a bit about how you're thinking about the question.

[3] (graph) Fine, and now could you tell me about any sorts of earlier experiences it reminds you of, or feelings it brings up?

[All three questions for each problem]

[4] (menu) Do you ever go to a restaurant with a menu anything like this?

Would you please choose a dish from this menu?

a) Suppose the amount of "service" that you leave is up to the customer; what would you do?

b) Could you tell me what a 10% service charge would be?

[If required "3 Bean Salad" - £2.53]
Does this remind you of any earlier experiences?

[5] (wage rise) Have you ever received a slip like this?

Suppose Jennifer is expecting a rise of 9% on her gross pay.
(a) Approximately how much will that be?
(b) Can you work it out exactly?
Does this remind you of any earlier experiences?

[6] (ketchup) Do you ever go shopping for food? Where would you normally buy it?

Do you buy ketchup? If you were (buying ketchup-or other food) and several jars were available, how would you decide?

a) Which of these two bottles would you buy? Why?
b) Which is better value for money?
Does this remind you of any earlier experiences ?

[7] (recipe) Do you ever cook using a recipe of any kind?
Do you ever bake a cake using basic ingredients?
If / when you bake a cake (or make another dish)?
Would you think about its cost? How?

a) How much would the ingredients cost for this cake?
Does this remind you of any earlier experiences?

[8] Have you ever thought about how much tutorial time is allowed for yourself as an individual student on a typical BSSS course?

(If requested, explain: each tutor is allowed so much time per week for each student in his/her seminar group).
Does this remind you of any earlier experiences?

[9] Have you ever been a member of a team, such as a football or hockey team?
Have you ever bought a set of uniforms, or equipment, together with others in a team or group?

Does this remind you..........?

Thank you very much. That is all the questions I have to ask you.

- Is there anything you would like to ask about any of the questions?

- How do you feel about the way you are able to use numbers these days.

[- How could the course best be arranged to help you with this?]

Is there anything you'd like to say about the way that the interview took place?

I'd like to ask you, of course, not to discuss these questions with other people on the course so that the people won't come to the interview with any preconceptions.

May I ask for your permission to quote things you have said here - in a suitably anonymised form - in things I may later write?

When I have had the transcript of this interview typed up - which you'll appreciate may take some time -
I'll offer you both a copy of the transcript and the chance to talk to me further about things that have come up. O.K.?
Thank you very much.

Prompts/Assurances

- While they are doing the question, (feedback) :
  NONE or
  "uh, huh" or "hmm"
- If necessary: "Can you say a bit more?"

- If they ask for feedback:
  "We can discuss the answers at the end"

- As a response to each answer:
  "Fine, thank you."

Additional Prompts

. If they seem worried about time, first: "There is lots of (1985) /plenty of (1986) time".

THEN (if this worry persists):
"Take all the time you need" or
"You don't have to worry about the time".

. If (ssem) reticent/nervous/worried about questions
This is just to see what you think/how you're thinking about them. It is not a test". (taken out after 86/3)
or "I'm mainly interested in hearing about your experience with Maths"(*)"with numbers"(†)or "how you're thinking about the question". or "Don't worry about getting the right answer" or "There is no right answer to that".

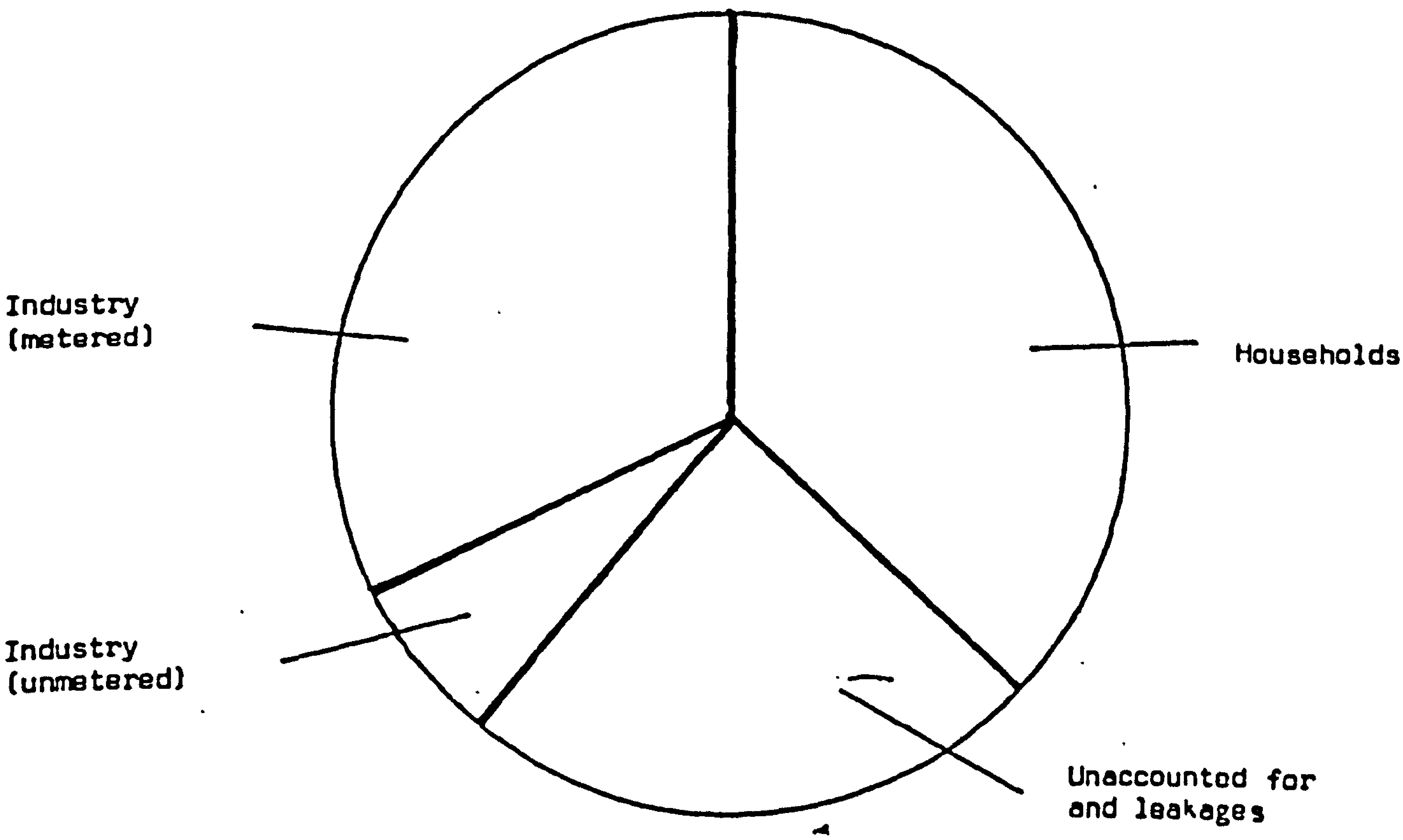
* Qu. 1-3
† Qu. 4-9

APPENDIX I2 Interview Problems to be Solved

[1] Pie chart

Looking at this 'pie'chart, which do you think uses more water - households, or industry with meters?

PIE CHART SHOWING WATER CONSUMPTION.



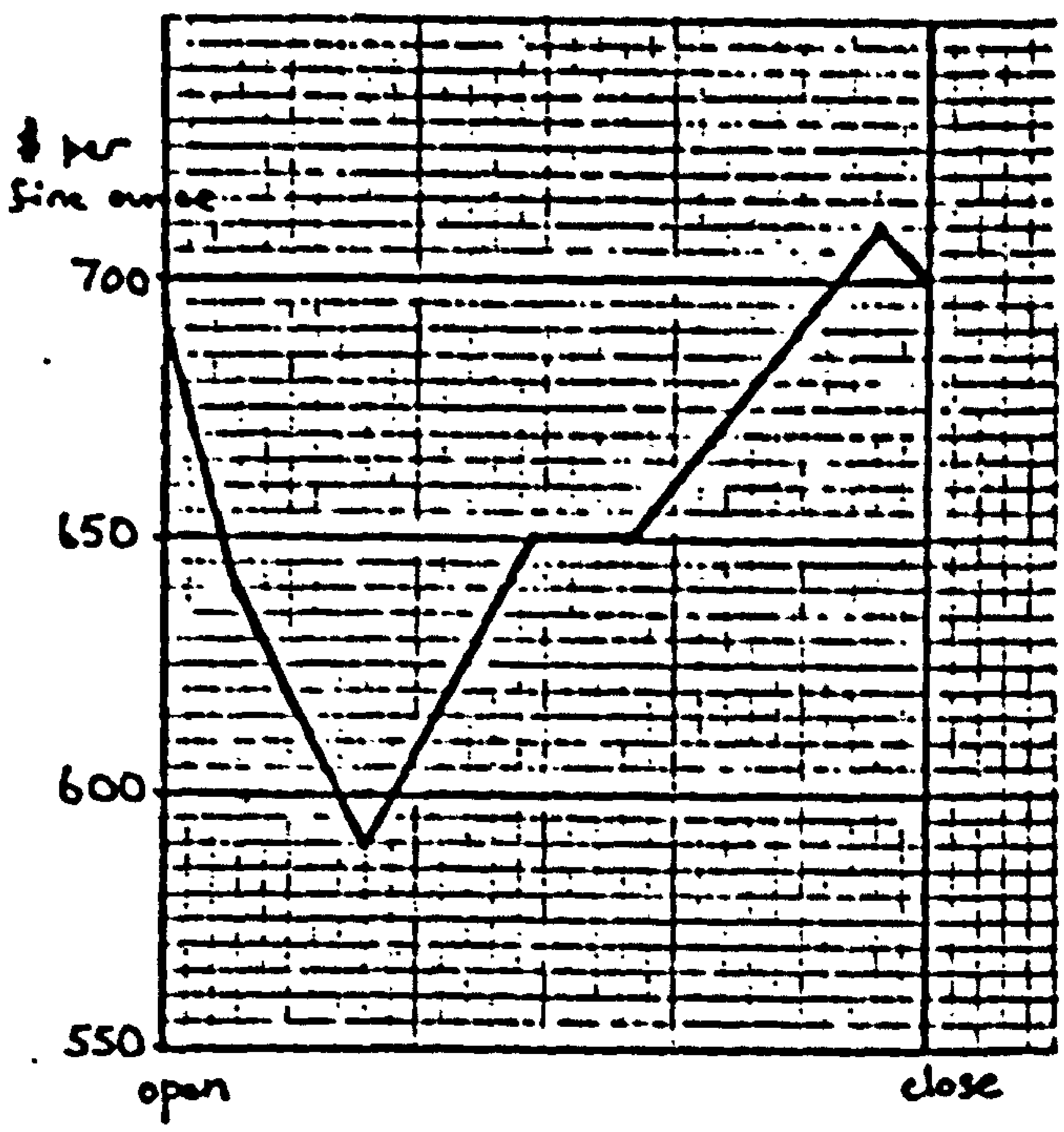
[2] What is 10% of 6.65 ?

[3]

Graph

This graph shows how the price of gold varied in one day's trading in London. Which part of the graph shows where the price was rising fastest? What was the lowest price that day?

The London Gold Price - January 23rd 1980



This graph shows how the price of gold (in dollars per fine ounce) varied during one day's trading in London.

[4]

CHICKEN MARYLAND	Served with sweet corn, banana fritter, bacon, fresh tomato, whole French beans, jacket baked potatoes with sour cream and chives or French fried potatoes. Roll and butter. Ice cream, or a selection from our cheese board, biscuits and butter.	£3.75
SEA FOOD PLATTER	Served with tartare sauce, whole French beans, jacket baked potatoes with sour cream and chives or French fried potatoes. Roll and butter. Ice cream, or a selection from our cheese board, biscuits and butter.	£3.53
GRILLED TROUT 10 OZ	Served with tartare sauce, whole French beans, jacket baked potatoes with sour cream and chives or French fried potatoes, Roll and butter. Ice cream, or a selection from our cheese board, biscuits and butter.	£3.81
Coffee	Special blend black or with cream	27p
Connoisseur Coffees	Served in large goblet glass with cream: Irish (*Irish whiskey*), Caribbean (*Rum*) Russian (*Vodka*), Parisienne (*Brandy*) Calypso (*Tia Maria*) Highland (*Scotch whisky*) Mine Hosts (*Cointreau*) Connoisseur coffees include sugar unless otherwise requested	67p

[5]

STAFF NO.	DEPT.	NAME	TAX CODE	DATE	PERIOD	BASIC SALARY/PENSION
	331788	SMITH JENNIFER	116L	07/10/79	28	66.560

GROSS PAY TO DATE	FREE PAY TO DATE	GROSS TAXABLE TO DATE	TAX DUE TO DATE	TAX THIS PERIOD R=REFUND	MISC. DEDUCTIONS	
1335.450	629.440	681.480	183.800	11.900		SAYE

GRAD. PEN.	NAT. INSURANCE	H.S.A./B.U.P.A.	SOC. CLUB	L.A.M.P.S.	R.I.P.	NAT. SAVINGS	TRUSTEE SAV.	DENTAL PAYM'T
	3.150							

	HRS	AMOUNT
STANDARD PAY	38.75	66.560
O/TIME MON/SAT		
O/TIME SUN/BHOL		
LOST TIME PAY		
LOST TIME NO PAY		
HOLIDAYS		
W/E CLEANING		

NIGHT ALL	
SICK BEN	
MISC PAY	
X-BONUS	
PEN FUND	1.650
	CASH

GROSS PAY THIS PERIOD	
66.560	
TOTAL DEDUCTIONS INCLUDING TAX	ADJ.
16.700	.330
NET PAYMENT	
49.80	

Jennifer is expecting a rise of 9 % on her gross pay.

[6] The larger bottle in this picture holds 30oz and costs 69p.
The thinner bottle holds 20oz and costs 52p.

[7]

VICTORIA SANDWICH

Metric	Imperial
100g. butter	4oz. butter
100g. caster sugar	4oz. caster sugar
2 large eggs, beaten	2 large eggs, beaten
100g. self-raising flour sifted with pinch of salt	4oz. self-raising flour sifted with pinch of salt

[8]

For a typical course on BASS, each seminar tutor is given an allowance for tutorials of 0,05 hours per week for each student in the group.

(a) How many minutes of tutorial time is each student entitled to , per 12-week term?

(b) About how many tutorials of 1/4 hours each is this?

(c) If there were to be a cut of 10%, what difference would that make?

[9]

Suppose you are a member of a newly-formed football or hockey team, with 12 members. You club together to buy a uniform consisting of the following for each person:

1 pair of shoes

2 pairs of socks

2 pairs of ~~socks~~ shorts

2 shirts

How much will your uniform (as above) cost , if each part of it costs as follows?

shoes	£15.00 per pair OR £40.00 for 3 pairs
socks	£30.00 per dozen pairs
shirts	£90.00 for ten
shorts	£72.00 for a dozen pairs

APPENDIX I3 Invitation to Interview

4 June 1986

Dear

As you may know, I am currently doing a study of people's use of numbers and "maths" in various areas of their lives.

This is to ask you if you would agree to come to talk to me about your experiences with numbers, and the way you use them - or not - in your everyday life. This would involve one-half to three-quarters of an hour, at a time of your convenience, some time this month. (Your name was chosen in a random sample (stratified) of BASS 1.)

How will the results be used? This is part of my work for a Ph.D. at the Univ. of London Institute of Education. I hope ,too, that doing this study will help me to contribute, both in teaching and in publishing, to making numbers and maths more interesting and less painful for people in general.

Whether or not you agree to an interview is of course voluntary, and nothing you may say - either in response to this note, or in the interview itself - will have any effect on your position on the course. Indeed, what you say will be treated by me in confidence - with the proviso that I will ask for your permission to quote what you may say about using numbers - in a suitably anonymised form - in things I may later write.

WHETHER OR NOT YOU AGREE to be interviewed, could you please return the form below to my drawer in the Staff Room on the ground floor of the Tower Block as soon as you possibly can.

Thank you very much.

Yours sincerely,
Jeff Evans

Jeff Evans

TO: JEFF EVANS

PLEASE __ I AM WILLING to be interviewed. I am free at the times indicated below. I understand you will offer me a suitable time through the BASS pigeonholes (giving 24 hrs. notice).

TICK
ONE __ I AM NOT WILLING to be interviewed.
Would you be willing to say why? ____________________

FREE
TIMES
Please tick as many as possible.

Time / Day	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7
Tuesday		X	X	X				X		
Wed.				X						
Thursday			X							
Friday										

From : ____________________

APPENDIX I4 Respondents Recruited for Interview and Categorised by Qualification in Maths, Gender, Age and Parental Occupation (n = 25)

No.	Name / Design'n	Qual. Maths	Gender	Age	Prntl Occ
1	company nurse	C	F	I	WC
2	betting man	C	M	O	WC
3	Jean	C	F	Y	WC
4	Keith	O	M	I	MC
5	Fiona	O	F	O	MC
6	young black woman	C	F	Y	??
7	Alan	C	M	Y	MC
8	toolmaker	-	M	O	WC
9	stockbroker	-	M	I	MC
10	Donald	O(equiv.)	M	O	WC
11	youngest son	C	M	Y	WC
12	male soc. worker	-	M	O	MC
13	engineer	A(equiv.)	M	O	WC
14	Ellen	A	F	Y	MC
15	convent survivor	C	F	I	MC
16	Harriet	C	F	O	WC
17	Sam (y. black man)	O	M	Y	??
18	young man	C	M	Y	Mixed
19	Peter	O	M	Y	MC
20	female soc. worker	C	F	I	??
21	manageress	-	F	O	MC
22	book-keeper	A	F	Y	MC
23	dependent daughter	O(equiv.)	F	Y	MC
24	hospital nurse	-	F	O	WC
25	office-worker	C	F	I	Mixed

Notes: Interviews nos. 1 to 9 were conducted in 1985, nos. 10 to 25 in 1986.
Qualif. in Maths: C = CSE; O = O-level; A = A-level.
Age: Y = 18-20; I = 21-24; O = 25+ years.

Summary Table. Respondents Categorised by Gender, Parental occupation and Age (Qualification in Maths indicated in brackets)

Gender	Males		Females	
Age	18-20	21+	18-20	21+
Middle Class	Peter(O) Alan (C)	Keith(O) no.9 (-) no.12(-)	Ellen(A) no.22(A) no.23(O)	Fiona(O) no.15(C) no.21(-)
Mixed	Sam (O) no.18(C)		no.6 (C)	no.20(C) no.25(C)
Working Class	no.11(C)	Donald(O) no.2 (C) no.8 (-) no.13(A)	Jean (C)	Harriet(C) no.1 (C) no.24 (-)

APPENDIX I5 Execution of the Interviews: Details

(a) Sampling methods and recruitment

The 1985 interviewees were chosen by a combination of random and volunteer methods. In a lecture on sampling I gave to BASS Year 1 in May, for illustrative purposes, I "selected" a random sample (size 10) from the students present, and 5 of my first 6 subjects were chosen thus. One other, interviewee no.4 (a middle class man who had been in my personal tutorial group in the first two terms), volunteered himself. At this point, I became concerned at the low proportion of men recruited (only two out of the first six), and and I asked three other men (nos. 7 to 9), known to me from my maths teaching group (or my "Learning to Cope Brilliantly with Numbers" workshop - see the general reflexive account in sec. 9.3.3.), to give me an interview.

In 1986, those to be interviewed were chosen by a process of stratified random sampling, in an attempt to enhance the representativeness of the results. The set of completed questionnaires from the autumn of 1985 was used as a sampling frame, and was stratified according to the three social structural variables found to be important in the statistical modelling - gender, age (18-20, 21+) and parental social class (middle class, working class and "mixed" - see sec. 5.6.1). From each of the 12 categories so formed, four students were selected at random for invitation to interview. (see NOTE 7, Ch.9) An invitation (see APPENDIX I3) for each of the 48 students selected was then put in the BASS course student pigeonholes at the beginning of June. In response to this, there 28 replies, of which three refused (on grounds of "work" or "too busy": two men and one woman), and 25 were contacted again to arrange a time. Eventually, 16 students were interviewed. (NOTE 8, Ch.9)

The numbers of students recruited to each category - gender by age by social class - in 1985 and 1986 are shown in APPENDIX I4.

(b) Conduct of the interview

At the beginning of each interview, I attempted to produce a relaxed atmosphere, e.g. by offering coffee or tea. I then described my work as

> ... doing research on people's experience with numbers and on what sorts of things help people feel comfortable with numbers, and what stands in their way. This is part of my work as a research student at the Institute of Education. So what I would like to do in this interview is to give you some space to talk about your experiences with numbers, and your feelings about them.

(See the interview script in APPENDIX I1.) After this information, I asked the student for permission to tape-record the interview - agreed in all but one case (no.25) (see NOTE 9, Ch.9) - and emphasised to the student that he / she did not have to answer any question if they did not want to. This was an attempt to position both of us in a research, rather than a "college maths" discourse; it was also based on my commitment to treat interviewees according to the principles of "informed consent" (International Statistical Institute, 1985).

Following this introduction, I moved on to the questions about the subject's "life history" (sec. 9.2.2), leaving time for them to share details of experiences with maths or numbers at home, school, college or work. I then introduced the problem solving, and the contexting questions, as follows:

> Now I've tried several ways to let people get into talking about their experiences with numbers, and the best way seems to be giving you some questions to try. So I'd like to ask you if you would mind taking a look at a few questions here. And, for each question, while you're looking at it, I'd like you to say:
> First, what sorts of other things that you do these days, if any, it reminds you of;
> Second, I'd like you to tell me as well as you can about how you're thinking about the question, and what your answer would be;
> And, finally, I'll ask you what sorts of earlier experiences it reminds you of and feelings it brings up.
>
> Now during the time that we're doing the question, I'll just note what you're saying. But at the end, if you want to, we can take some time to discuss any of the questions you wish.

Versions of these three questions were repeated for each problem. The student was given at most only neutral feedback while attempting the problems. Further, a set of standard prompts and assurances were prepared - for cases where the student was worried about taking too much time, or about her / his handling of the problem. See the interview script in APPENDIX I1, and the list of problems available in APPENDIX I2.

I was concerned about time-keeping, so I stopped at the problem being discussed about ten minutes before the agreed time. This meant that a few students attempted all nine problems and some as few as four (e.g. no.10, Donald, who told of many experiences) - but the average number attempted was about six. (Two students did not really attempt any problems; see the discussion of hypothesis (5) in Sec. 10.5.)

To conclude the interview, I asked generally about two areas:
- "anything you'd like to ask about any of the questions [or the interview itself]"; and
- "how you feel about the way you're able to use numbers in general these days".
This was followed by requests not to discuss the questions

with other people on the course, and for permission to quote things they had said in the interview - "in a suitably anonymised form"; hence <u>all</u> student names used in this report are <u>pseudonyms</u>. Finally, I gave an undertaking to provide a transcript of the interview to the student, so as to share some of the output of the interview with them.

Towards the end of the interview, I reverted in most cases (in some, explicitly) - to my position as teacher in college maths. In a number of cases, the subject asked to discuss "the answers" for the problems; this was always done. In addition, in one or two cases where the student's thinking during the interview had indicated basic misconceptions, I offered a tutorial to help clear them up.

J Evans - Interview 86/5

JE about yourself. What track are you on?

S Planning.

JE You're on planning, right. Is, from, is that the track that you came to do?

S No. Sociology. But I only chose Sociology because I didn't know what else to do.

JE Right, right. OK. And, uh, how old were you when you joined the course last September?

S 19, oh, um, 19

JE 19, OK. How's it going on Planning?

S Fine.

JE [Stats] um, where did you study most recently before coming to the Polytechnic?

S Um, I was at Art College, ~~first~~ for a year. ~~Whichxxxxxxxxx~~

JE uh huh, which one was it?

S St Albans, one in St Albans

JE St Alban's, uh huh. Arts college of and design - S) and, how much if at all did you use Maths?

S (laughs) um, I didn't use it all. Well, later measuring up frames and canvasses but that's about all.

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JE um hum. Right. um, and do you have any qualifications in Maths?

S uh, O level and A level Maths, and O level Statistics.

JE Right. What was the O level Statistics like? How did that compare, say, with what you've done here this year?

- 2 -

S um, well not really of much use really (uh huh - JE) um, from what I remember. Very basic and sort of like conventional, um, sort of, different types of graphs, those sort of things, uh, co-efficient of co-relation, things like that, but not, sort of, like, questioning, that sort of aspect (right - JE) at all

JE So you've done a lot (S: um) with Maths and Stats (um - S)
Have you, have, what sort of work have you done most recently? Have you had jobs?

S Yeah, well, I've got a job at the moment... Working in a factory, an electronic factory (uh huh - JE)

JE Does that, does that involve your using numbers at all?

S No, not really. Not at all really. No, a practical thing

JE uh huh, what are you assembling (yes - S) are you assembling components, (yeah - S)

S Well, units of things

JE uh huh. I see. Do you have any special tools to use, soldering or is it easier to (

S soldering, yeah. um, it's not machine, it's hand assembling stuff, um, yeah, there are tools, yeah, spanners and stuff like that (uh huh - JE) and before I've worked in a shop [ ] on the till, things like that

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JE Did you find you were using numbers in important ways there?

S Only very basic sort of, of things - adding up and things, not really in my head. I mean

JE No. What did you have there? You had a cash register or calculator?

S A till. Yeah, yeah.

JE Right, any, any other experiences that might come under the heading of work using numbers?

S [Not really ...]

JE Right. OK. Thank you. Now I've tried several ways to help people get into talking about their experiences and the best way seems to be giving you some questions to try. Would that be alright with you? (um hum - S) um, so I'd like ask you if you'd mind taking a look at a few questins I have here, um. For each questions while you're looking at it I'd like you to, to ask you what sorts of other things you do these days that it reminds you of. And, secondly, if you could tell me as well as you can about how you're thinking about the question, (S - uh hum) and what sort of answer you would give, and, finally, what sorts of earlier experiences it reminds you of. I'll ask you those each time so you don't have to remember it (laughs - S) During the time that we're doing the questions I'll just note what you're saying but at the end if you want to we can come back
048 to them and discuss them . OK. So here's the first one. [1]

S [18 sec.] .... [laughs] ....

JE Does that remind you of any, any other things youdo these days?

S How do you mean? the pie chart or the

JE Anything about it really, just whatever comes up for you I'd be interested in.

S Well, it's, sort of, very familiar, y'know I know exactly what it means I think (uh hum - JE) um, that's it. I mean,

JE hum, that's fine. (I don't really have to think about it - S) Right. 'cause it's so familiar (um - S) Right. OK. As far as what it asks there, which would you think uses more water, households or industry with metres?

S Households.

JE Thanks. [S laughs] We'll, we can come back to, I'll just note your answer at this stage. And come back to it if you
Does it remind you of any other earlier experiences? Or indeed earlier experiences at all?

S How do you mean? Do you mean, ~~whether~~ where I've seen this sort of thing before?

060 JE Yeah, and does it, does it bring up anything especially clearly? Like you might have remembered doing in a certain time in your life, or with

certain people, like that

S Well, um, my statistics [thing?] (uh huh - JE) ....I think I've been familiar with it, you know, ~~at~~ from quite an early age (um - JE)

066 JE From, from school would it be, (S - yeah) from or ~~some~~ othe rplaces

S Yes, yes, well, earlier, I suppose, I don't, I mean, that's about it really seems very [? common ?] (uh huh - JE)

JE Would it have been as early as primary school?

S Yeah, well, uh, junior school., um, think so, yeah.

076 JE Right OK. Good. um, here's another one. Does that, does seeing that make you think of anything you do currently? [2]

S Currently ~~Partly~~/ um,

JE things you do in which you might use

S Everyday life? (..something like that, everyday life, or other things you do at College - JE).

S um, cooking (laughs) (cooking, uh huh, I see. Oh, that's interesting. How does it come up with cooking - JE) Well, dividing recipes into recipes which are made for 4 and then dividing it into to 2 or something. The, I - I can't think really of where I use numbers like that in everyday life except ~~with~~ sort of really basic things like adding and multiplying (um, sure -JE) but I mean, as for at on the course, obviously,
088 using all that sort of thing, but I don't know, maybe, I don't know,

JE That's OK. Whatever comes up for you, and if nothing comes up, that's fine.

S Yeah. Well, maybe I just do it instinctively. (yes, yes - JE) You know, it's not really a problem (right - JE)

JE Right. OK. so how whould you think about that if I asked you what's 10% of 6.65

S I'd just move the decimal point (uh huh, right - JE) uh, .665 [3]

JE OK. Does it remind you of any earlier experiences?

S um, I don't know, I mean, just sort of something I've known, you know for ages, you know, um, ..sort of ages and ages I suppose, I mean, I can't put a date on it all. ~~I~~ Can't think of when I wouldn't have known that.

JE Right, right. No, I'm not asking you to put a date on it... ~~It's~~ just that you might have said, Oh yeah, I remember we did that with that teacher in thrid year or whatever, you know, you might say something like that but

S Well, I think, you know, sort of, primary school, no, junior school (uh huh - JE) I think so anyway.

JE So you did it as early as that. (S: umm) Right. Thank you. good. So, uh, here's, here's another one. Um, Does that remind you of anything you do currently? [3]

104 S ...[10 sec.]...............................Well that's a bit more the stuff ~~which is~~ you see within the course. um, obviously a bit less ~~immediate~~ familiar but um, you know, but I, sort of, ~~still don't~~ understand it.

JE Why are you a bit less familiar with it?

S Well, it's, it's less something I might use you know, just naturally, or, you know (uh huh - JE) but then again, you see, a lot of that sort of stuff about (right - JE)

JE Where do you, what sorts of places do you see it?

S Well, advertisements, (um - JE), books, y'know, [headlines(?)]

JE Right. OK. I think it asks you there which part of the graph shows where the price was rising fastest.

S That bit (um hum,-that bit, sort of the first, the second ~~quadrant~~ quarter - JE) [3a]

JE And what was the lowest price? (There - S) uh huh, and how much was that?

S [very confident] Oh, um, ...£598 (yeah, you're happy with that, 590(?) dollars (dollars - JE) ... [3e]

JE Right. Does that remind you of any earlier experiences that one?

S [3 sec.] um, ...no, (laughs) I'm not giving you very much information am I?

JE No, it's fine. It's fine, I, um, I don't have any preconceptions about what you could say, Indeed, So, I've got lots of questions [S laughs] so I'm not worried about running out in our time, so, uh, yeah [S laughs]

S Well, I don't know really. um, probably where I would have learnt to do that sort of thing maybe in my Statistics O level course. (um hum - JE) That sort of, um, ~~rising~~ starting scale there, at 550, that sort of thing (right - JE) instead of nought (yes - JE)

JE That's something you learned (S: umm) to do there, right.

S I should think so, yes.

147 JE How do you remember that O level Statistics course? Was it-in terms of how you felt about it would you say it was enjoyable, not enjoyable, interesting, [S laughs] dull, useful, not useful. You've said a bit about that already, I'm just wondering how you felt about it generally, you know when you look back on it a few years later.

S I can't really remember too much about it but I think I, I think it was boring, um, I think the way it was taught was boring. I don't know if it could have been more interesting. I just remember it being, just being boring, um, I really can't remember much about it [laughs slightly nervously]

JE um, it's some years ago now, clearly, isn't it (yeah - S)

S um, I think it, it was, sort of, basic and it was odd that, um, it was a very basic course. Not, it didn't have any interesting bits, like, you know, have people manipulate statistics, or anything like that.

59 It was just the, how to do statistics, y'know [7 sec.] that sort of the things

JE Well, I'm sorry you had a boring course. [S laughs]

S It was only a year, so

JE It wasn't too bad, then, eh [laughs] right. Thank you. um, here's, do you ever go to a restaurant with a menu or anything like that. [4]

Uh hm [very quietly]
S [8 sec.] Um [very quietly]

JE Yeah. You do. Uh huh. And, um, could, would you choose a dish that you would, if you were hungry and ready to eat, like to eat

S Shall I pick one out? (yeah, yeah - JE) um, [7.8 sec.] that one there

JE That one, OK, The sea food platter. OK. Right. Now, supposing you've had your meal and and that's what you had and you'd got to the end and supposing it was a restaurant where the service was left to the customer to decide on, how would you decide what to do, about that what would you do for service? [£3.53]

S um, [5 sec.] ...what, like a tip you mean (yeah - JE) well, 15% I suppose [4A]

JE 15%, uh huh. OK, um, could you tell me what a 15% service charge would be?

182 S Well, I'd have to use a pencil and paper

JE Yeah, sure, you're welcome to, yeah. That one needs a bit of encouragement to ~~work~~ write I think.

S ....[7 sec. / inaudible / coughs / 6 sec.]
[see work-sheet] Well, twenty three and a half pence no, that's wrong....[12 sec.] [whistle] [just wrong......oh.... (is it wrong? - JE) Yeah. [JE: what] [laughs nervously?] um, ...I don't know what I'm doing, um, ...

JE You might not be used to doing these questions in such a setting as this so (yeah - S) Take, there's lots of time, don't worry

S [15 sec.]............. 52.95, 53 pence [4B]

202 JE uh huh, fine, thank you. How did you decide it was wrong 'cause you

S I don't know, well I (one moment you said, Oh, that's wrong - JE) yeah. Well, I just, I don't know why, I just did that. I, It wasn't thinking (uh huh - JE) um, when I dideded that but ...uh, I just ~~thought~~ saw that it was obviously not right. (uh huh - JE)

JE What looked, what looked wrong about it?

S Well, it was far too small.

JE uh huh, it should have been around, around what,

S I don't know really, it was just the wrong figure (uh huh, uh huh - JE) I don't know [why I think] ... [dunno, jadunno].

JE But you did, you did see really that it (yes, - S) that you felt it was wrong and wanted to redo it. OK. Does this, does this sort of situation here remind you of anything, any earlier experiences a restaurant, a meal, thinking about service and so on.

S [3 sec.] No [laughs quietly]

JE No. (I don't usually pay [laughs normally] - S) You don't usually pay. Someone else has paid.

S Well, I don't know. Can't think of anything in particular I mean I usually look at prices and things, you know, add them up in my head, and [...?]

JE Right. So, if you were ordering a meal would you add up the cost, with several dishes like here maybe adding coffee or something, would you add up what it was going to be in your head.

S um, yes,

JE Right, even if you weren't paying?

S Yeah, well I don't want to be [an?] expensive.

JE oh, right. Right. OK. Thank you. So that's that one. This is number 5. Do you ever get slips like that? [5]

S [5 sec.] Yes.....

JE and, um, what sort of slips have you had like that?

S ....Well, just saying how, you know, a pay slip (uh huh - JE) saying how much ~~you're~~ I'm going to get ~~per~~ in one week, and how much I have got in ~~a~~ the year. in the financial year and, um, uh, P45...

JE Right. That's the thing you get at the end of the year.

S Yeah. ..[7 sec.]

JE Right. OK suppose Jennifer's expecting a rise of 9% on her gross pay, approximately how much would that be.

S [laughs] [5 sec] .....um, ..oh, about a rise of about £6.65 or .66 , on top of

JE Right. On top of

S But obviously a bit less because that's 10%.

JE Right. If you were, um, can you work it out exactly?

S [10 sec.] .... 72.55. Seventy-two pound, five-five [five?] [5]

JE um, thank you. Well, does, does that remind you of any other experiences you've had

S Checking through how and many I'm going to get, ~~on the weekend~~ (uh huh - JE) reading my bank statement, um, ...check to see if they've got it alright [Single] (um, - JE) It doesn't always happen.

JE um, it doesn't always happen that they've got it right (no - S) no. What sort of mistakes have you found?

S uh, (in the last few years - JE) paying tax [what?] well, I mean, you know, adding it up, pay tax , income tax, so...have to pay it back. That's about all

JE Fine. Thank you. Do you ever go shopping for food? [6]

S Yes. I should be shopping for food at this moment, actually

JE Should you. Well, I'll (This is my timeslot really - S) Oh, I see, I see, oh, you've got it that carefully scheduled. (Then) Until what time do you have to shop for food?

S uh, it's a late night shopping night so I'll probably, well, usually get there about 5:00 and finish about half past five (uh huh - JE)

JE Right. And do you go far from here.

S Well, I go near where I live. [illegible] Well, [illegible]

JE uh huh, well, is it one of the supermarkets?

S Yes, a Safeway a Sainsbury I'm afraid

JE Oh, I, why do you say I'm afraid.

S Well, I don't know. Just- They get too much support I think.

JE uh huh, yes, they do get a lot. Right. Anyway. I mean, we won't, um, we're coming up to the end of the time anyway (I wasn't saying - S) we've already negotiated, no, I want to keep very close to time, ~~and~~ so we're coming up to that so, um, we'll just finish this one shall we (~~yeah~~ - S) [eagerly] Yeah, OK. Well, do you ever buy ketchup?

S No.

JE No. Do you buy other things that might come in jars of different sizes? Jams, or mustard, (umm) or relishes

S um hum.

JE If you were buying something in jars and several sizes were available how would you decide which one to buy?

S [1 sec] Best value for money.

JE Well, supposing it was ketchup. I'm sorry, I'm not a ketchup eater [Single] either but this is the question I've got. Supposing you had the choice of those two, which would you buy? It tells you at the top, the prices are marked on but it's 63 it says here

S hum, ...[10 sec.]......um, the bigger one.

JE The bigger one.

S Yes.

JE OK. And why, why would you buy that one?

S Because I think you'd get more for ~~your money~~ 69p. ~~what you're paying.~~

JE How did you, can you tell me a bit about how you ?

73

S um, well, just sort of saw that 30 oz, 30 oz into 69 is less pence an oz than 20 oz into 52 (um hum - JE) That'sort of ... [?] [6]

JE um, um, fine. Does that remind you of any, any experiences you have? That sort of, sort of quesiton.

S um just, yeah, well, shopping really, [6 sec] that's ~~all~~ more of an everyday thing, petrol and things

337 JE um hum, how does it remind you of buying petrol?

S Which [going?] to get [

JE uh huh, right, sure

S Not that that usually [(?) would] (uh huh - JE) but it might do— um, (right - JE), just shopping, buying.

JE Right. Does it remind you of any ~~hEarlierexperiences~~ earlier experiences, seeing that?

S I don't know. It's just, I don't know, just ~~daily life~~ everyday, you know, really I haven't always bought the shopping (sorry, you - JE) I haven't always bought/~~the~~ you know shopping but ~~and~~ I've been aware of that but it's just, don't know, just think about it automatically.

JE Would you, would you, would often do that, you're going shopping for, say is it the week's ~~shopping~~ shop now — Or at least a fairly good sized shopping. would you do calculations like that very often, do you suppose during your shopping tonight?

S uh, not, well, between things ~~it~~ which are the same like a big or a smaller size bottle, but not really between differen t goods 'cause, um, ~~I like to eat~~ it's really what I like to eat best (uh huh - JE)

JE So different brands —

S Yeah, I've never, I mean [laughs] I keep a check on how much I'm spending to make it about £15.00 (uh huh - JE) doing the shopping

JE So when you say different goods would that be like different brands you you have your, (S: yeah) you have a favourite brand of say a jam, would you?

7

S Well, that sort of thing, or better vegetables or whatever. Eggs, and things, I mean, that sort of thing. I mean, I do when, I do think about it it when's it's a case of buying something which is better [spending?] value

JE

JE uh huh. Right. So it's sometimes the brand and wanting the brand, and sometimes the better value (um, - S) Right. Right. OK. Thank you very much. That's all the quesitons I have to ask you. Is there anything you'd [S coughs] like to ask about any of the quesitons?

S Not really [v. quietly] (JE: hmm?) Not really

JE Could I ask you in general how you feel about the way you're able to use numbers these days?

S [3 sec] uh, [4 sec.] well, I feel sort of confident, I suppose, (um) 'cause I ~~think~~ feel I <u>should</u> be confident

JE Why do you feel you should be confident?

S Well, um, [4 sec] given the sort of qualifications that I've got and that the course is aimed at people who have less (yes - JE) but I still, [3-4 sec] it's not, uh, the numbers aren't, uh, don't really give me the problem; the working, you know, the calculations. But It's more sort of [3 sec] [quietly] talking about them. [laughs nervously] (uh huh, uh huh - JE) I don't know if anything ~~that~~ gives me problems but, the bit, I mean, like, on the most recent work sheet there's the bit which I've groan, when I think about it, about, you know, talking about how you might [3 sec] use numbers instead of the actual ones amount [which you produce?] using a [calculator calculation] (um hum - JE)

7

JE So could you give an example of one thing that you said made you groan?

S Well, thinking that, uh, talking about research — uh, sampling, that question about sampling (uh huh, yes, yes - JE) I mean, I think you have to tackle it but I'd just be much more interested in doing a calculation, getting an answer (um hum - JE) you know, having that done

JE That's interesting. Why do you, what is it about the sampling question that you say it makes you groan. Does that, ~~it~~ mean you, find it less interesting?

S Yeah, [1 sec] I find it less sort of stimulating. to have to write about the numbers, rather than actually just working something out,

SC/5.
WORKSHEET

that being ~~it~~, and having come up with some [illegible] answer, a definite answer. (right, right - AE) but I mean, I don't know, maybe I just don't find it very interesting (um - JE) [S laughs nervously] well, if it was, it might be too different, you know, I certainly just find it easier to do the actual Maths [illegible] (uh huh - JE)

JE Right. OK. Is there anything you'd like to say about the way the interview took place?

S Not really, I didn't have any.. difficulty

JE um hum. Could I ask you, um, not to mention to people that we did questions of the content of the questions, just so they don't come ~~to the interview~~ with any preconceptions and could I ask for your permission to quote things you've said, here of course in a suitably anonymous form, if I should later write some things about people's feelings about maths

S Yeah, yeah [perfectly happy]. OK

JE Yeah. I'm, I'm fortunate to have some money from the Poly to type up a transcript of each interview and, it'll take some time, of course, but when I've done it I'll write you and offer you a copy if you'd like to have one (OK - S) to look at and if you want to talk about it any of the things that come up there, you could have, we could take some time again. Right. OK. Thanks, thanks very much. I especially appreciate it when it's people I don't know who say yes, 'cause I don't know you very well (no, - S) because I don't teach your year. Coenting to come for an interview [S laughs] OK. Hope the shopping goes well.

S [speed / 15 /5]

JE Right. Take care then. Bye bye.

END OF TAPE

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INTERVIEW 3 Jeff Evans

The microphone is down at this end

] JE Ok, why don't you uh, why don't I ask you a few questions about yourself and then we'll test and make sure it's been working alright.

S Alright. (laughs)

JE So, how old were you when you joined the course last September?

S 18

JE 18, right... and where did you study most recently before

S um, Gateshead technical college.

uh huh, whereabouts was that?

Gateshead

In Gateshead,

Gateshead, yeah

JE uh huh, oh well, good so you're from Tyneside eh, S: That's right. yeah. Um, what sort of things uh, were you studying there?

S Psychology, sociology J: right and communication studies.

JE uh, huh, uh huh. There's uh, there's quite a good degree in Communications at Sunderland Poly I think.

[Tape off]

S I sound horrible on tape.

JE Uh, you feel you do. No, you sounded nice there. I mean, it depends on the quality of the machine, right but this one is supposed to be ...

S get used to your own voice as well. (J Yes)

S 'cause I had to be on film as well and I just refused to watch it.

[36] JE You had to be in a film, uh huh ..

S Yeah, I didn't, I refused to watch it.

JE Uh huh. So, anyway I think that's working fine and as long as the wheels are turning which they are I think we can go ahead, Good. So, so, um, how much did you use Maths in your courses at the college?

S We used statistics in Psychology but we used Colin Robson which was more or less like a cookbook, you know.

JE Uh huh

S but I found it good, and we used to get a Maths lesson every Friday because a lot of people couldn't cope with the statistics. (Oh, I see, right) but it was more or less statistics rather than Maths, although we ~~I never~~ did branch into what you call Maths, and not statistics.

[053] JE Colin Robson is that a Methuen book, a little thin Methuen book, or ..

S I'm not sure, it's a little paperback. It's a really good book.

JE Good. Um, so what level qualifications do you have in Maths?

S CSE Grade 3,

[060] JE CSE, GRADE 3, right

S Not good at (sorry? - JE), say, I wasn't very good at all.

JE Sounds ~~Well, that's~~ fine. (S: Um [quietly]) That was the exam that they put you in for and you got it, eh?

S Yeah, and I got an arithmetic 2. (ah - that's interesting)

Arithmetic 2.

JE Uh huh, is that a CSE or was that a ...

S CSE

JE Ah I see, good. I always learn something about the exam system when I do these interviews. So, what um, have you done any, any sort of work, weekend jobs or summer jobs or when you were at the technical college, have you done any work recently.

5] S I work in a bar at the moment (Jah huh, in London?) in [inaudible].. I also worked in a baker shop where I had to add up and I did things like cleaning [ ], you don't really need maths do you.

JE What was that, the third thing?

S I've done ~~as a~~ cleaning, I worked as a cleaner. (uh huh) Worked on a milk round

2] JE Don't you, don't you with the milk round, don't you have to uh, make change and

S Yeah you do, yeah [right] (um - JE) but it's only on a Friday morning, mostly it was delivering (It's right, uh huh) and that was you know, when I was at school

JE uh huh. Well, so what time would you have to get up for that? (S - 4 o'clock) whssh - every Friday? (S - No, every day) every day, boy (S - Saturday and Sunday) wow, so ......right, well, OK, I think that's all the questions I wanted to ask you about yourself. Um, now I'd like to ask to to take a look at a few questions I have here. For each question, while you're doing it I'd like you to tell me as much as you can about how you're thinking about it, how it seems to you and what sort of other tasks it reminds you of, and secondly, I'll ask you to give me an answer and finally, I'll ask you if it reminds you of any earlier experiences you've had with numbers or Maths and any feelings that doing this particular question brings up. OK. So, uh basically it's just a chance to, to give you a chance to talk about your experiences and feelings about Maths, so during the time that we're doing the questions I'll just note down your answers so that it

doesn't interfere with the flow of what you're saying but at the end if you'd like to, uh, we can take some time to discuss any of the questions that you'd like to, OK, so, um, and, of course I'd like to ask you not to discuss the questions with other poeple 'cause I'll want to use them (J umm) with others, OK. So, here's the first one, this is uh, one. I'M going to give you some paper too, just in case you need ~~any~~ it, a couple of sheets over there. so, uh (S - what it reminds us of) yes what ever task it reminds you of. [1]

S Well it reminds us of when I first went into the comprehensive school and you were given certain tasks to see which set they wanted to allocate

[135] you to (J- oh, uh huh), and concerning Maths there was a lot of these (J - really), kind of charts, uh huh) yeah. I think I did quite well in them because they put us , like, in the top set in Maths (J: good!), and considering the CSE Grade 2 I obviously wasn't up to it (J - uh huh, well that was before or after you'd done the CSE?) Oh, Before. That was in first year (J - oh right) the first out of five years, but I was in the top set for three years.

JE uh huh, good so you're telling me you're good at pie charts.

[145] S Yeah, I was good at pie charts, I must've, I just presume what it was because that was what mainly these questions (J: uh huh), and I would say households, using the most water.

JE Right, fine, thank you. Did it, uh, um, yeah, good, good, thanks, OK here's the second question. Again you've got some paper there if you want it (S - you got a pen?) Yeah. [2]

R.ely at this?

[158] S Right. Percentages I've mugged up on, 'cos when I went to school [I wanted to go to work in a shop?] and I always keep mucking it up and I always keep getting the formula wrong, so I looked up [last night] (uh huh, good). 6 point ....
I've done it wrong again. um, I always get the formula wrong ? (at work (J - uh huh), ...[20 secs]....[? I don't know all this ?] [172]

[177] .... It'd be 0.65, wouldn't it? (J - um hum)
It's just a guess, I really don't know (J - um hum, what ah)
Percentages have always [kind of confused?] and I always forget the formula,
I always forget how to do (uh huh) [and but] there again it doesn't take that long to relearn them, which I suppose is/ something to do with your memory I really couldn't (J: umm)
do it (mmn, mn, but you, you - J) I feel that I should be able

[1:7] to do it because I feel it is quite relevant , I feel like [of all the Maths I embarrassed ?]

I feel
it would be an advantage, but I couldn't do it, unless I was shewed,
I don't think it would take me long to pick up (J: uh huh). well, I knew it wouldn't, cos

?] I could do it last term.

JE Right. You may find that this, you may find that in this situation you react differently than you would if you were at home, so, ...

S I can't often do it first hand, but it just takes me to run it through once and then I can do it again, but (J - uh huh) I always forget how to do it.

JE OK. How did you, you came up with an answer, though; How did you come with that you,

S I just moved the dot.

JE OK you moved the dot, and how did you know how to move it?

S Umm... Just from what I'd learnt in the past.

JE So you were using a rule that you remembered. (S: Yeah) Yeah (S - Is that the correct answer?) Um, I'Ll tell you about that at the end, is that OK. If you, we'll go back. At the moment I'm just going to be like a researcher with you and just listen to your ..., at the end I'll become a Maths teacher again if you want me to, OK (S - it doesn't look right) doesn't it? It doesn't look right (S - no) That's fine.

?] S I was afraid you were going to ask us to do things like this and I thought maybe [I should've prepared a bit, ... I didn't?]

JE um, no, no, you didn't have to study up for this.

S I thought we were going to have to...

JE Oh did you? uh huh, that's interesting. Yes, I haven't always when I've done these interviews but it seemed to work quite well, so. Did this remind you of anything, you say it reminded you that you wanted to work in a shop. 4[131]

S uuh, went for an interview to work in Fenwick's (J - um hum). When I left school I didn't really want to go to A'levels and all the rest of it (J - was that in Newcastle) Yeah, I knew I was going to get percentages on exams then, so I just learnt them again.

JE um hum. And they gave you a test at this interview? (S - yeah) and um, there were percentages in it. (S - yeah) I see, uh huh

S So I just learnt them again, and then I learnt percentages last term, (J - uh huh) one of the worksheets (J - good), then I forget them again.

JE Oh well, you can obviously relearn them when you need to, so that's the main thing, isn't it? Yeah, don't worry about anything you say in this test, if you find something you want to work on you've got lots of time so (S - laughs - right). OK Right, here's another one. This shows how the price of gold was changing over the course of a day in LOndon. Which part of the graph shows where the price was rising fastest? [3]

S It was rising fastest? (J - yeah) I've to show you. (J- um hum). OK.

JE So, that's towards the close of the day isn't it. OK. And what was the lowest price that day?

[346] S um... 590, same, yeah, 590.

JE 590. OK. Thank you. Does that remind you of any other things you...?

S Well, it reminds us of what we did last year using the graphs, etc (J - uh huh, what in the college) Yeah (J - yeah), I mean like in Sociology, etc you tend to use a lot of graphs (J - Do you - uh huh) to illustrate

JE That was your sociology A level, was it?

[255] S Yeah, and Psychology, and um Communications. (J: interesting) [I tend to think ...?] think they're relevant now, and [understand it?] .. [? etc. ?]

JE Good, OK do you ever go to restaurants with a menu something like this. You ever been in a restaurant with a menu like this? [u]

S um, similar to that but / I'm vegetarian so ~~I wouldn't~~ eat any of that.

JE / Oh alright, OK, so (S: I had to [? ?]) uh, that a good point, we don't have a vegetarian dish. This is a few years old and I guess things have changed a bit. OK? let's say we put on a vegetarian dish of um, what would be a nice one, you'd like to have if you're having your dinner. (S - um a kidney bean salad) OK, so, a kidney bean salad, let's say that would be £2.75, how's that? OK so, we'll put on kidney bean salad (S - I mean I have done in the past) right, OK, so that's what you'd choose. Suppose the restaurant was one where the service was left to the customer, um, what would you do about leaving something for service in a restaurant like that. (S - how do you mean?) Well, what would, supposing it just said, you got you bill and it said £2.75 for your salad and at the bottom it said service is left up to the customer. What would you do about that, say, these days?

S Well it would depend how much money I had and it would depend how good the food was, and it would depend what I thought of the actual service but I'd probably leave something, ~~but~~ I'd leave 25p (J - 25p) to make it up to £3.00 (J -up to £3.00). [4]

JE Right. OK. Right. OK. Does that one remind you of any situations you've been in

S [laughs]. Yeah, every time I go out (J - yeah, why?) um, well, 'cause you always think of leaving something and I've never ever got enough

[330] money so I've always got to like, count it, . . . you know, (J - you've got to) like count it, ~~you know~~ but, especially at the moment, I've been kinda lookin at it you know, like in America where you've gotta pay 15% tips, I'm going to have learn percentages again aren't I? (J - um hum, yes, it's ah) it's a kind of problem. (J-hmm).

JE Well, they might do them for you, they might calculate them for you. [laughs] (S: Yeah?) J Yeah (S: It's quite difficult though) Uh huh, So when are you going to America?

S Sunday

JE Oh, you're going on Sunday, right, uh huh. You're going for the whole summer?

S Yeah.

[310] JE Oh, so what will you do about, supposing this was in America, S: uh..) it could be chicken maryland and, um, how would you calculate

S Oh, I'd just take a calculator.

JE How would you calculate a 10% tip, let's say, for the chicken maryland?

S Uh, I'd probably use a calculator but at a guess, I always mix it

[320] up, do you put the 10 over the 3.75 and then ~~10's~~ times by 100? .. No? [quietly] [sounds skeptical]

JE So, you say put 10 over 3.75 and times it by 100? (S - yeah) uh huh. um, let's see will that give it to you?

[8sec] [quietly] (J...um)

S.....Or is it the 3.75 over 10 times 100? I don't know. I know it goes something like that.

JE uh uhu, uh huh. Will you take a calculator ..Sorry

S Yeah, (J - you ~~want to~~ will take a calculator) Yeah, I might 'cause

[330] I've got like a little one. (J - have you, uh huh) I use it when I go shopping [? with myself?]

JE Oh good, yeah, it's made a difference/for people hasn't it/, the fact that you can take that. Do you have it with you now, for example. Do you carry it around with you? (S - not at the moment but when I go shopping I take it round)

JE ....OK did it remind you of anything else?

S No, not really (J - no) I do ~~n't~~ always follow the prices though

[340] for fear of bein' ripped off, if you like.

JE uh huh, How do you mean follow them?

S I always add up y'know (J - oh, right). [? to get an idea of ?] ~~[illegible]~~ what I expect it to be and compare it with what they give you, JE Right, oh, so you do it in your head as to what you expect the bill to be.

S In a restaurant I do, not when I go shopping (J - right) [I do it roughly?] when I haven't got my calculator...

JE Uh huh, good, good oh, so you do quite a lot with numbers.

S Oh yeah. I think my [favourite?] [first?] ~~with~~ numbers, ~~but~~ are this kind of number but like I say [when you get on Maths] last year, I think, and you've gotta do things like algebra, and all the restof the formulas, I just don't think it's really relevant and I can't really relate it and I won't even allocate myself the time to ..

JE You won't allocate yourself the time ~~to~~...

S I don't seem to, no (J - uh huh, to really get to grips with it) Yeah, but I like percentages and graphs and things 'cause I think that, I think they're uh - I can't think of the word

JE Relevant? (S - yeah) yeah (J to) [illegible]

S Last year I think we did gradients and all the rest of it. I ~~will~~ would be try, 'cause I thought, well you've gotta try and learn these things because I didn't really in school, especially when I was moved down, but I still just didn't do it and I wasn't, you know, prepared to go and allocate myself the time whereas after a Core Theme lecture I would go home and read the book. (J - um, um) Statistics, and I think's different, because I think, like, they do help ~~you put~~ to show ~~over~~ you what you're trying to ~~show~~ put over, etc. but (J right) with ~~out a~~ [illegible] equations?] now, I just don't think I could, I just wouldn't (J - uh huh) Maybe I could, but I wouldn't.

JE uh huh, so you're saying after Core Theme you read the book (S - yeah) but after Maths you didn't feel inclined to go home and read the books.

S No, that was on last term's, but this term's I found quite interesting, [I [illegible] the gradients?] I wouldn't ~~like~~ [illegible] go home and say well could I only do one, like, you know. I can do the mean,

mode and the median, but I've been able to do them all the time, you know.

JE Good, OK, thank you. Here's one, here's somebody's wage slip [S - [illegible]] and she's expecting a rise of 9% on her gross pay. Could you tell me first of all approximately that would be. [5]

S ...about £1.50

JE Sorry

S £1.50

JE a pound fifty would be 9% of her gross pay.

S I should think so, .. estimate

JE Right. OK. (S - estimating) .. and, um, could you work it out exactly what the (S - no) 9% would (S - I don't think I could) no, OK, what does, what does that remind you of, this .. [5]

[390] S um,.. just thinking [when we'd get?] wage slips again -

JE uh huh. Have you had, let's see, the places you've worked, ~~have you had~~, do you get wage slips, I suppose.

S Yeah, I do.

JE Do you? In the pub, do you get wage slips?

S Yeah, yeah, I do follow them through as well.

JE You check them out to make sure they're right (S um) right, yeah

S It's nothing like this one, obviously (J - no, no, that's pretty complicated) Yeah, it is, (J - more complicated than we get, I think)

[410] JE Right, OK, thank you, um. Do you go shopping for food? (S - yeah) um hum, and what sort of places do you shop in, where you normally buy your food? [6]

S Usually go to Waitrose 'cause it's the nearest (uh huh, right) to Enfield

JE To Enfield, right, and do you ever buy ketchup?

S um, I think I bought it once since I've been here.

JE Uh huh, OK, um how would you, if you were buying it how would you decide which one to buy?

S What you got the most from for the least money.

JE Uh huh? OK, so...um OK well, look here's a couple of hypothetical bottles, OK? and the larger bottle holds 30 oz and costs 69p and the thinner model holds 20 oz and costs 52p. Which one would you buy? Which ~~one~~ is better value for money?

S ..... I think I'd buy this one.

JE um hum, right, can you say why?

-20] S Judging by the top one you'd get more and it's cheaper than that one and ~~it's cheaper~~ the difference in price, 17p, would, uh ...

JE Sorry

S I said, that was 17p price difference, more relevant

JE Right, how do you mean more relevant?

S Because of the difference in the ozs, the 10 ozs (J - right) I think it works out cheaper in the long run (JE- right, to buy this, the thinner bottle) Yeah

-29] J Right, OK, thank you.
(conversation with someone who has come to the door) [JL on Computer Course]

-46 JE Uh, so, uh... Right, do you ever bake a cake?

S I used to (J - uh huh) but not any more (J - uh huh). I did at school.

-43] JE Uh huh, using... Would you do it using basic ingredients or a cake mix?

S I would use the basic ingredients.

JE Uh, when you baked a cake were you concerned about cost?

S No

JE No, if you did it at school they gave you the ingredients, I guess

S No, my mother did.

JE uh huh, uh huh, OK, so here's a, let's see. Here's a possible cake. Have you ever made a Victoria sandwich (S - yeah) or do you know what a Victoria sandwich is, you know what a Victoria sandwich is - good. OK, so there is the uh I'll just give you that one, how

[450] much would the ingredients cost for that cake.

S uh........[20 sec]......Do you want me to write it down?

JE um hum, sorry (S - ~~do you want me to~~ write it down?)

JE Yeah, sure.

S [I'll just do it approximately?]

JE Um hum, right

S ....[60 sec]........uh
.... 60p

JE 60p, good. OK does that remind you of anything?

S uh, we used to have to do this at school.

JE What, this kind of question or baking that kind of cake?

S Baking that kind of cake and that kind of question, you had to compare convenience prices and these prices.

[480] JE Oh, I see, uh huh...

S and I had a problem because I couldn't remember how many ozs is in a pound (J - uh huh). I might have put 16 for the flour and 12 for the sugar or vice versa (J-uh huh). Then again I might not have.

JE You're saying with this particular question you might have (S - yeah)

JE Yeah, uh huh.. Did you, did you do this one using metric or imperial?

S I changed over.

JE You changed over part way through, did you?

S Yeah, uh .. varying things ..

JE uh huh, ~~that's~~ uh I see, good. What made you choose, like, what did you do for butter, for example?

S I used the grams (Just lost) because .

JE uh huh, right, right and what about the flour?

S I don't know, um.. I used pounds.

JE uh huh, and why did you use the pounds on that one?

S um, I don't know, um, just did

JE uh huh, was it that it seemed easiest.

S Yeah (J - I do) I'm not sure how many grams is in 1 pound. (J uh huh, uh huh)

JE Good. OK Thank you.

S [?the answer'd be better after all ... be getting a different price. wouldn't it?]

JE I'm not sure

S Yeah um, 25 grams in brackets (J - is that right). It's not exactly, but

JE Yes, the relations aren't exact are they, let's see.. they're all a little bit difficult. Fine. OK. Can I show you one more then. (S Yeah [quietly])

[8]

This is, uh, suppose you're a member of a newly formed football team, and you all club together to buy a uniform consisting of the following for each person, a change of socks, shorts and shirts and one pair of shoes, how much will a uniform cost if each part of it costs as follows. Of course, in a team you can get certain cheaper prices and if you buy things in boxes of 10. (S - so you want it for 11) I want it just for one person. This is for you and you're going to have these, you're going to have 1 shoes, 2 socks and so on.

S You want me, I'll work it out (J - yeah)

JE Does this remind you of anything you've ever done?

S Yeah, it reminds me of the problems you do, I can only remember doing them at junior school (J - uh huh) and are there going to be 11 or 12 in this football team, 12 to buy one for yourself (J - yeah) 'cause that makes it easier (J - we'll have 12, yeah, that's OK so that's a good decision then if it makes it easier)

035 [530] ....[50 secs].

JE Can you tell me what you're doing now?

S Yeah, finding out how much it'll cost for the team and then dividing it by 12 (J - umm) to find how much it'll cost for one and then I'll have problems with the shoes 'cause [there's only two?] (J - oh, yeah, right) and then just add up how much it'll cost for me (J - uh huh) and add another two on (J - Oh yeah)..[10 secs] ... no I can't do it that way, 12 so, ... it's £30.83pence

JE um hum, thank you. Have you ever been a member of a team such as a hockey team or football team?

S Yeah, I'm a member of the hockey team

JE Are you, for the poly? (S - [no] and for ... and for Bladen) Good

JE And for ..

S Bladen (J - is that where you live up north?) Yeah and I play for them in the holidays

JE I see. So what's the hockey season?

S In the winter(J - it's in the winter) starts in September and finishes in April, but you play summer hockey (J - right) it goes all the way through but that's only down in London, ~~we~~ you play indoors

JE uh huh, I see. So where do you play?

S We play all over, Hendon, it's all over. ~~It depends on~~ where you're playing (J: uh huh) sports halls, all over, anywhere.

JE Where do you play in the poly, where does the team train?

S We used to play up atWorld's End Lane but we don't anymore. We play at Enfield down the road but it's not very good (J - oh, really). Quite, we're going to complain next year.

JE Was World's End OK?

S No, it was terrible. Potholes (J - was it? oh dear, ssh) Not very good at all. we want to play at Trent Park because it's much nicer there but I think we're second ~~in~~ within the sports department (J - oh yeah). It's just the rugby teams get that

JE 'cause the Rugby teams get Trent Park.

096 S And the footbal teams that get Enfield, they get the grass cutting

Ours is never ~~good~~ cut.

JE So there's some points to be made there, eh. (S: Right.) Good, and did you ever, were you ever involved in buying a set of uniforms (S: Yeah) for the team?

[656] S Yeah, up at Bladen, we just bought tops, skirts rather, not buying tops, (J - oh, so, good) supposed to be getting a new one from the college but we never got one but we will next year (J- right, it's the Student Union that pays for that is it?) Yeah, it is but we had £400.00 given to us and we haven't got a penny of it and they're saying that we're spending it on transport but the football team, they only got £50.00. They got about 2 quid - in any case,

ours is just £1.00 (J - right) and they've gone much more ~~places~~ paid for than we have and getting all their transport paid for, we've worked it out, you see (J - uh huh, right) And also they wouldn't let them go to Wales and we had a match there 'cause they said they couldn't afford it (J - oh, I see, oh dear) We argued that we could

JE So did you go in the end?

S No. It just went by, (J: oh dear) no explanation (J: oh) becasue there's quite a few, you see, all the teams from Enfield, the other half's from Hendon and we think that Hendon have been getting all the money but that's just our observations.

JE The Hendon members within the same team have been getting more money than the Enfield members.

S Yeah, That's what we maintain (J - really) Well, really. It's quite beyond a joke: C goes out with K and J , and spend all the money. 'cause we were quite worried why we weren't getting any money, we ~~were getting~~ haven't got nothing, but the football team got £50.00, but were allowed to go further afield.

JE Well, some campaign's to be mounted (S - right). Good, OK. Well that's all the questions I have to ask you. Is there any~~thing~~ of them you'd like to go over?

S I suppose I can learn how to do percentages again.

JE OK, you asked me about one. You asked me whether one was, oh, 0.65, that was question 2 wasn't it, and you... yeah... Say it was a meal and you were giving 10% service how much would you expect to give if [2]'

S .... Well, I'd probably give 65p but maybe it should be a little bit more

JE um hum, how much more?

S about 80p, I think, I don't know (J-for, for) see I'm getting quieter, (J - quieter?), quieter, yeah (J - because of your cough you mean) Yeah. I think so

[725]

JE I can still hear you fine so, well normally, with 10% you were asking what, how do you do it, is there a formula? Do you remember what 10% actually means.

S the 10 percent of the cost? ... a tenth of it?

JE It means a tenth or it means 10 per cent which is ten per hundred which is the same as a tenth so when it's something nice like 10 percent you can actually turn it into a tenth but in any case, whatever thepercent is you can always put that on top and then put the cent, the hundred underneath, so that's, you were asking me in connection with one of these or was it maybe, it was this one, yeah, you see now there I was asking yo what would be a ten percent service charge and you said, is it ten over 3.75 or 3.75 over 10. It's, what would it be now, given what we've said here. [4]

S 3.75 over a hundred (J - yeah, it'll be) times 10 (times 10)

JE So in fact, it'll be these two changing places. It'll be ten over a hundred times 3.75, (S - right) and remember you've got a good feel for numbers because you know that it's just about 65p or in this question when I was asking it to you just as pure numbers you said .65 right away so you've got a good feel, and that's, as you say, just about right, but it could be a bit more, so if you were going to work that out now, if you had ten over a hundred times 6.65 what would you get, if you were to work that out?

S ....0.65,(uh J -) 0.665 (J - yeah, 0.665, strictly which is strictly speaking, we go back to the pence example)(S - 66 pence) yeah (J - yeah, 66½ if we've still got half pence, so you set it up as the ten per cent, then you did whatever cancellations you can and not surprisingly it came out to what you already knew, which is 1 tenth, and then you can just divide 10 into that. So, if you were in America how would you do it? If you had $6.65 and 15%, if it was, I mean I thin k it depends on the place but you're right it tends to be more like 12½ or 15%, again you don't have to, tip unless they make it clear. That's right, you can do that. [S count 15/100]

S Can I, like, that? (J- looks so what's it going to be approximately) I haven't a clue, (J - just make a, (S - Roughly, guess it'll be approximately) because 10 per cent was 60 odd pence, (S - yeah) yeah, you see, you've always got your feel for numbers to guide you through and then if it's worth doing it exactly you can do [810]

if it, with this, it clearly doesn't make much difference between 65 and 66. OK, so you all ready to get on the plane and do your tipping?

S Yeah, yeah. Just not eat out, (J - um) Just not eat out (J - sorry?) Just not eat out, I won't be able to afford it just basic things, probably ~~can't afford it~~

JE even, what about basic things?

S Just, even if you go for a takeout, apparently, you gotta pay it as well.

JE Oh, I see.

S I don't know.

JE I don't know, so I think I don't think you pay it at Macdonalds, for example or wherever. That'll be Maine then, I'm not sure — Where are you going to go?

S Maine. I've got a penfriend in LA but I don't know if we'll make it there, do you know Jane?

just chat .... J. So you're going to work [for Camp America] for some weeks. S Eight. J. Good, that's a very good thing to do then. Indeed. S I haven't had a holiday for 5 years, so this will get me to America. It's the only way I can ever make it, and it'll help with, some time. J. Sure, good for you.

[900] JE Is there any else you'd like to ask about the questions?

S No, not really, and that I can think of.

JE How do you feel about the way you're able to use numbers generally?

S I feel quite competent for what I feel I need in real life, statistics again probably needs brushing up on, like percentages I should be able to do but I always forget (J- you see how easy it is to remember now) Yeah, yeah. When I worked in a pub, when I first started I was quite [ ] , but now I get them mostly right, and it (J - good!) becomes with practice, and there again I just really don't like gradients and things, can't see the point unless you want to do maths, but even at school I always maintained that Maths should be a subject, option that you take ~~and not~~, whereas arithmetic should be compulsory (J - I'm) (J - you presume that ...?) (J - a bad) Maths teacher, but I like tables, graphs and things I think they're very illustrative, necessary but I think I got put off by Maths because of all the complications. I think you

Worksheet
85/3

you have to practice it, to get it actually [ ] ~~a lot of~~ most people don't, because it's just not relevant to reality. So, my maths last term I liked it at the very beginning, we were ~~doiying~~/ Pythagoras and all the rest (J: right) of it, and the theory behind it which you never did at school, but then we started doing gradients, etc and I just didn't like it at all. And this term I can see where [? it fits ?]

JE What do you mean by the theory behind it, you said you liked Pythagoras and the theory behind it.

S I liked reading ~~it~~ that book Morris Kline because I've never ever thought about it before, been presented it before. You know where it's coming from, some background, instead of being totally abstract. It seemed to mean something.

JE Good, and thinking about the future how could the course best be arranged to help you hold on to the feelings of confidence you have about maths, and numbers. Because it isn't really maths anymore now is it. (S: Yeah)

S Umm... I think it's necessary to do something every week because in you do forget, because it is quite easy not to follow it through, (J: uh huh) [? ?] and I think just like what we've (J: what?) been doing and what I presume we'll be doing in research methods, following things through and to expand. Things (J: uh huh) that would be related to social science and also to life. Because I don't just think it's social science, I think it's more or less life, you know, that kind of maths but I can't see the point in doing, I keep saying gradients, I can't even remember the word they're doing. Because I think even if you just relearn them agin in the first term and forget them by a year's time and therefore I think it's a waste of time, really

Q.7
20
23
12
5
60

+ 4

$\frac{10}{100}$. 6.65

0.665

Q.2?

Q.8
12 shoes 160.00
12 jackets 30.00
12 pr. shirts 72.00
12 shirts 108.00
370.00

$12 \overline{)370.00}$ = 30.83
36
100
96
40

JE So, I don't know if I've told you about my research but it's basically on how people work with numbers, the things that help them to be comfortable about that and the things that stand in their way and I'm doing it for my own studies for a further degree at the Institute of Education so what I'd like to do in this interview is give you some space to talk aboutyour experiences with numbers and your feelings about them and the way I'd like to get into that is to, in a moment, is to give you some questions to try. OK (um hum - S). Um - Now, but first of all could I ask you some questions about yourself (yeh - S). OK. Um, take a little bit of paper here, um, how old were you when you joined the course last September?

S: umm [very quietly]

S OK [quietly]

S I was 26.

JE 26, right... and where, where have you studied most recently before that?

S Um, at Kilburn Polytechnic and Hendon Polytechnic.

JE Uh huh, the Hendon site of this poly or ..

S No, ah, it was Hendon College of Further Education.

JE Oh, right, Uh huh. Is it, when it was already on the same site as ..?

S No, it's actually sited at Burnt Oak (oh, right, OK - JE) and I decided at the age of 23/24 that it was about time I embarked on some further education (J uh huh) and I took 2 A'levels (J uh huh) One was Psychology (J right) and one was English Literature (uh huh - JE) and Language because I've always had a barrier there (uh huh - JE) with actually being able to intellectually put down my thoughts on paper. Speaking orally is no problem (um hum - JE) but intellectually being able to collecti.. collect my thoughts and actually put them on paper was a very difficult task. (uh huh - JE). So I decided to attempt to combat that (J: We'll just try ..)

.... tape turned off .....

JE Certainly the volume's fine. Good. So, um, Psychology and English Literature and Language. Did you, how much did you use Maths in either of those if at all?

S A lot (um hum, yeah - JE) in the Psychology. I had to do Psychol ... I had to (J. umm) do A level in Statistics. (did you) Yes (As well - JE). Yes, it was part of the A level. I had to do Practical Research Methods as well as the cognitive and developmental side of Psychology (uh huh -JE)

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JE So you actually sat an A level exam in Stats?

S Yes.

JE So, do you have A level in stats too?

S It was part of my Psychology, yes (Really - JE) and I was very surprised that I actually got an A for that, I don't know how (Good for you - JE) but I did.

[85] JE I didn't know that, I mean in the sense of doing partof one exam with another. Great, so there was some stats. Was there much Maths?, I don't know if you make that distinction, or..

S Yes, I mean, there was, yes, I mean there was a lot of significant or probability tests that had to be carried out on the experiments and research that was done. (uh huh, right - JE). Everything had to be tested and accounted for (right - JE) and - to know that whether we could infer any information that we've actually learnt from the experiments. (J: Right, umm) We had to, we actually had to submit 10 experiments that we'd actually completed within the period of a year.

JE So you did that A level in a year?

S I did both A levels in a year.

JE In one year, both at once. Were you full-time? (I wasn't - S). My goodness. OK. [sighs] What level qualifications do you have in Maths?

S I have a very poor CSE grade and a very poor Maths grade.

JE um - Maths grade. Does that mean O'level?(O'level - yes, S)

[100] S I was very unlucky at school because I had a very, very good Maths teacher. She was very, very aware of people's problems of actually understanding certain terminologies and she used to work through step by step and then she left a few months before I actually sat both my, the CSE and the O'level and I went down hill very rapidly. I don't know whether it was a question of confidence (J: uh huh) or inability anyway but I, I didn't get the grade that everyone was expecting me to get.

JE Do you, do you have any ideas as to why that might be? I mean, Was there anything at the time you felt was going on ...?

S Well, I just felt that once she'd left, um, it became - it sounds funny - but it became very, very mathematical. I mean, in the sense that everything was equations, and everything was theories rather than working through and explaining a theory step by step. Nothing, after she left, nothing was explained (I see, OK - JE). We were just given the formulas and told to get on with it. (J: uhm) I sort of went downhill from there onwards (J: uhm) and I think for anyone doing Maths it's a very bad thing just to be given a formula and not to have the knowledge and the information on how to use it. (um hum - JE) And I felt, I think, well, I'm sure that's what happened. I'm not the sort of person that can reproduce just anything parrot fashion or just absorb something unless I understand it, I have to understand specifically and to understand all its implications, to be able to use it later on. (Uh huh - JE)

JE Oh, I'd like to, uh, maybe we'll come back to that, ask you about that. What sort of work have you done most recently? before you came on the course?

S Um, I've been a social worker, a nurse.. a nursery officer and unqualified social worker on and off for the past 10 years. I've also worked within the commercial
[155] field as um, a financial advisor which is broking basically (uh huh -JE). I've also worked ~~for~~ within an employment agency. They were just sort of flings in the pan. They were, they were dispersed between the 10 years of doing social work, really, That's my main area.

JE Right. So, and what's, how did you use numbers there, if at all? In the social work 'cos that seems to be your main thing.

S Yes. In social work very, very little. Um, well, actually, well I actually had to, I mean I was actually responsible for the children's educational needs so I was teaching them to count (uh huh - JE), um, using beads and blocks and that sort of thing but otherwise, apart from using it in work, apart from checking a register and knowing how many children I had throughout the day which is obviously
[176] essential (right - JE) for legal purposes, not very much at all.

JE And in the financial advise?

S A lot, a lot .... (unfortunately)

JE What kind of things do you do there?

S Well, I was having to sell policies and um, (what, insurance? - JE) insurance policies and life policies and advise people on how to make as much money as possible with as little investment as possible, and considering I can't undrestand any amount over £10 it was very difficult because I can't actually think greater than £10 [laughs]

I've never seen it, so therefore I can't actually visualize it (uh huh -JE) but I was having to calculate the amount of money one would get back after a period of 10 years. Um, I was having to explain how particular endowment policies worked and so a lot of figures all the time.

[200] JE Good, so ... Fine, OK. Um, now I'd like to ask you to take a look at a few questions I've got here, OK, umm ... S: oooh [quietly] What's the matter? (It's alright, paranoia's struck - S) Oh, No, I hope you won't (Are they simple? -S) Well, I'll show you, you've seen the first one, you've seen essentially what it's about. For this question and each of the others, while you're doing it I'd like you to say as much as you can about how you're thinking about it (um hum - S) and whether it reminds you of any other tasks that you've done recently (S: uh hum). Secondly, I'll ask you to give me an answer and thirdly, I'll ask you what sorts of earlier experiences with numbers it might remind you of, OK, and any feelings it brings up (S: OK), OK, so, during the time that we're doing the qeustions I'll just note your answer because I don't rather than discussing it because I don't want to interrupt what you're saying but at the end if you want to we can take some time to discuss any of the questions and I just want to ask you, of course, not to discuss the questions with other people because I only have one set, OK. [laughs] S: OK So here we go. Here's the ah, this is the pie chart and it says looking at this, uh, which do you think uses more water, households or industries with metres.

S I should think industries use far more water. (Uh huh - JE) um, the reason I [1] say that is because, um, .. industries use water for cooling, um, implements, for cooling down technical equipment, um, whereas households would just use water for washing, for baths, for toilets and the capacity of an industry is much, much greater than the size of a household (uh huh - JE) Usually, there might be 4
[236] or 5 people in a household but that ~~doesn't~~ certainly wouldn't equalize the number of people and the amount of equipment in the industry (J: uh huh). What it reminds me as you initially said, it reminds me of a cake or pie, um, but also having to work out percentages at school of how big this portion was or how many portions I could get inside a particular shape, um, I always had difficulty with that. I didn't enjoy it all. School wasn't a particularly happy time for me anyway so you might well find that a lot of my answers will be negative.

JE Uh huh, OK, fine, whatever they are is fine. Right, so it, it, you say it does remind you of school.

S Definitely reminds me of school. No doubt about it. J: uh huh I'm ah, yeah, this is one of the tasks I specifically remember having to work out how many portions of cake I could get out of a block (uh huh -JE) or how many children, how, yeah, how many

sweets would I need to give to 10 children if everyone was to get an equal share, or .
um, ah, and I never, I was never explained how to work through it step by step
[116] so it certainly makes me feel ~~a bit~~ very anxious. (uh huh, to see a question like
this? - JE) Yeah. I don't actually trust my own, um, perception, you know, to
actually give the correct answer (J. uh huh) because I don't feel I would, Idon't know how
to work it out properly so therefore I don't think I would give the right answer if that
makes sense (uh huh -JE) ..... I mean, the shape also reminds me of, um, having
to work out, uh, the diameter and the circumference of a circle and that sort
of thing. I quite enjoyed that. (uh huh - JE) Yeah, the radius and (uh huh,
um hum, ~~good~~ - JE)

JE So would that have occurred at a different time at school?

S Yes, yes, um, working out, yeah, I mean, I think, working out how many portions you can get out of a cake is quite an early (Yes - JE), one of the first tasks you do when you're actually even learning to count, how many portions of cake can you get out of one whole cake (right - JE), um, I think that's probably one of the earlier, um, mathematical sums you're expected to do. Probably goes back to junior school (uh huh - JE)

JE Right, whereas the other thing you mentioned about percentages at school and having negative memories, when would that be?

S um, that probably would be in my secondary school. I was certainly learning about percentages and how to calculate the circumference of a circle in my secondary school, and that was with this teacher that I got on quite well with actually (uh huh, before she left - JE) yes, though I think maybe that also has a lot to do with it, one's attitude towards your teacher (J. uh huh) and also how comfortable you feel within their presence. Whether you can actually trust them, in a sense if you've got a fear, you can actually say to them I don't undstand this, please go over it (J. mmmmm) whereas you actually feel some teacher would actually laugh at you
[310] or just disregard that you actually want extra help (um hum - JE) .... Yeah, yeah I mean I actually think that's quite, quite relevant, your um, rapport with, with a teacher. I mean, even now, when someone will say to me can you help me with a Maths problem I'll be very, very particular in actually going through step by step and showing them the calculations and working out so that they can actually not only see it, but they can actually understand it and question it if they don't understand it. I think that's very important in gaining knowledge and going on to the next step (um hum - JE). Can I have the next question now? [laughs]

JE Um hum. Yeah, sure, (laughter - S) sure. Here we are. Finished with this one, so um, what's 10% of (laughter -S) of £6.65. (laughter, horror! - S) horror, yeah [?]

S shock, pain, anxiety. Yeah, well, I was never very good at percentages. I need my calculator.

JE It's OK, you're welcome to it.

S Oh, except I haven't got it. Right, I, I remember (J. uh huh) that when I'm supposed to find 10% of a figure I move the decimal point but I'm never quite sure which way. Um, I assume, in this case, 10% of £6.65 has to be less than so I think it would probably like . 665? Is that right? (Fine, thank you ! JE) [2]

JE Oh, I'll, I'll tell you at the end (you'll tell me at the end - S) OK (OK - S)

S Yes, but the only rule I remember is that I was supposed to move the decimal point one way of the other but I was never quite sure which way. Um, It would seem ridiculous to me if 10% of £6.65 would be 66.5 so I think that's, logic comes in here, I'm afraid (um hum - JE) to calculate the answer.

JE OK. What does that remind you of? any recent tasks, or any things which you do these days, or...

S Yes, recent task on Maths worksheet 4 (uh huh - JE), how to calculate the percentage of people greater than Princess Diana or less than Princess Diana's height and that worried me greatly as well because I actually don't think that I understand technical uh, movement of working out these things. It's either sheer guess or get your calculator out. I don't actually understand the mathematical, um, steps, of getting from one answer to the next. (um hum - JE) so, yes, it certainly reminds me of Maths Worksheet 4.

JE (um hum) Can you get help on that or are you getting ...?

S Yes, Yes (yeah - JE) I've done that now anyway.

JE uh huh. Good. Does it bring back any earlier memories that one?

S Um, well, again of having to try and work out percentages, um, problems, mathematical problems, having to work out, um, miles per hour and, um, how fast a car would be going if it were doing so many miles per hour. (uh huh - JE) All the same and, ah, the, I call mathematical problems that I never quite got to grasp with. I mean, even now mathematical problems and percentages still worry me because, as I said, I don't actually understand the mathematical steps to working them out. (uh huh, right - JE) I think that was the problem, even, forgive me for saying so, (J. uh huh) in the course here, is that a lot of information is given on the assumption that the people doing the course actually understand the basics and actually have been through the steps previously to coming here and that's a lot of the problem, that People actually, either they haven't done Maths for 13 or 14 years, in which case they might well have known the steps (yeah - JE) and They've forgotten them now (J: umm) um, and too much is taken for granted, I mean, I know some people think that it's

[381] terrible to talk to degree students like babies but personally I'd prefer to be taken through every step again so that I have the knowledge refreshed (J: uh huh) the knowledge is refreshed and so that I then can go on to progress. I don't think that if you haven't the knowledge fresh at hand that you can then attain the next step because it's, it's like building a tower block without the foundation! Everything collapses underneath you (uh huh - JE) and I feel in some ways that's what's happening

[396] now. We're having to absorb information so fast that the foundations aren't being laid.

JE Is that in Maths, especially or ..in other things?

S Mm Yes, (Yeah - JE) - especially in Maths as well. I mean we've had, we've gone through a vast amount of information within a period of - what - six months from the basics - fractions, and adding up, subtraction (uh huh - JE), um, to calculus and ~~we're~~ now on to ,um, regression lines and calculating coefficients, now onto statistical tests. It's a vast amount of information to cover when some people

(405) actually haven't done as much maths as I've done. I mean, I've done these statistical tests, It's the basics I'm not too happy about, um, and I think it's a vast ground to have to cover at such a speed. (um - JE)

JE Does that, going that speed, does that remind you of anything earlier, is that a, is that something you've experienced other times?

S As I said, I wasn't particularly happy at school so I, I find that this speed actually is related to any academic work, that one is expected to absorb information without questioning (uh huh - JE). Poeple, teachers, I find, actually don't like to be questioned, they don't like to have any of their ideas, um, of their lectures criticised or, or interrupted because it interrupts their flow of thought (J: uh huh) um, and so I was always questioning, always asking because it was too fast and I was never, you know, as I said before, it's essential that to be able to use any knowledge that you understand <u>every element</u> and I find even now, here, people don't like being questioned. I'm very often being told off for intrrupting, questioning, interjecting, and to me that's the process of learning. (um hum - JE). I think it's essential. I can't, I'm not,uh, you know, a blank slate, (J: umm) I do have thoughts, I do have a brain, and, um, I expect to be able to use it, in anything, you know, whether it's Maths or Philosophy or Psychology or what, (um - JE) you know.

JE Did you, I mean is that, let's come back to that at the end. It's maybe, yeah, it's something. OK. Can I give you another one? (Yeh - S). OK. Here's a graph.

38] This graph shows how the price of gold varied in one day's trading in London. OK. There it is, the gold price and first of all, could I ask you which part of the graph shows where the price was rising fastest.

S Rising fastest, OK (um hum - JE). [10 sec.] Um, maybe it's me being ingnorant, um, I can certainly see the, I can see dollars per ounce on the left hand side of the column (yes, that's right - JE) but there doesn't actually seem to be any time specification along the bottom which I find quite confusing, apart from it states that the opening of the day, closing of the day. It doesn't actually tell whether you opened at 6:00 in the morning or 4:00 o'clock in the morning or you finished at 11:00 o'clock at night. I'm saying this because my father's a stockbroker, so therefore I do understand a little about opening and closing (right - JE) ~~but it~~ doesn't give ~~me~~ any ~~specific~~ period of time but, um, the chart certainly seems to rise rapidly, um, ~~about the 5~~, when gold seems to be at 580 (J: uh hum) um, a couple of hours after opening, (um hum - JE). (That's all I can say, I can't say (right, fine - JE) more than that because there doesn't seem to be any specific; and again, I would assume

.3] just mid-afternoon when gold is about 650 it rises very rapidly to 720 and that's just before the close (uh huh - JE) An hour or so before the close.

JE uh, which is rising fastest?

1:] S um, I mean there actually appear to be two peaks here (uh huh - JE) but [5 sec.] um, I [3A] should say maybe (J: uh huh) when gold is at 650 it seems to rise very rapidly in the afternoon until the close and afternoon business, you know, afternoon trading....

JE Right, OK, so that's when you reckon it's moving (S: Yeah) fastest (Yeah, - S) just before the close (Yes, I reckon so - S). OK, OK, and what, uh, what was the lowest price that day?

S um, the lowest price that day was 580. (J: uh huh) It's much easier to be able to work out [3B] mathematical calculations when something is in pictorial form, or for me anyway. It's more pleasant to look at, it's, it's easier to work out because you can actually see it, it's in front of you, You're not having to translate an equation or methematical termin ology into something that you can visualize; It's already visualized, (right - JE); It's already there and it's very easy to follow lines, to work out where the highest point is or the lowest point is or to tell you, ie when is the best time to buy and sell gold, or when the peak hours of trading were.

JE Right, OK. Does this remind you of anything you're doing these days or ...?

S um, well, ...parts of the graph work, um to find out whether there is, um, a relationship between one variable and another, Not necessarily. I mean, I'm not doing economics but I would assume that those in economics, ~~history~~ this would be very, very valuable for them, In Psychology I don't use this very much, apart from if I were going to analyse when the best time to buy and sell would be.

JE um hum. OK. Does it remind you of any earlier experiences with this sort of thing?

[50] S It doesn't, it doesn't actually remind me personally of any mathematical experiences no, apart from the fact that, as I said, my father's in the stockbroking business and it's been something that's been around all mylife and something that I've had to be very aware of, and something that also we weren't ever allowed to talk about at home (um hum - JE). Apart from that, no.

JE You weren't allowed to talk about his work, at home (Yeah, that's right - S) but you had to be aware of it, you said you had to be aware of it but you weren't allowed to talk about it. How did that, I mean, what was the resolution of that? It sounds contradictory, but I'm not sure ...

S Well, yes that's right. You had to be aware of the fact that money or any trading time, meant loss of trading, or increase in trading, increase in money. You had to be very well aware of monetary values, but we weren't intelligent enough or academically bright enough to be able to grasp, in his eyes, the concept of that money and time was money, and money was time and that every minute of the day meant trading.

JE Uh huh. How did you .. who said ..how did you know, as you said, you weren't intelligent enough to grasp that? I mean, it's sounds like you did, because the thing you just told me before was that you did grasp that or it sounds like

[52] you did.

S Because, because of the negative comments that were received (uh huh, from your father to you - JE) yeah, children should be seen and not heard and shut up, and shut up, you don't understand so don't say (uh huh, uh huh - JE) You're touching lots of bad points here. It'll all come out on the tape (uh hh, I see, OK - JE)

JE Yes, I'm not trying to probe but I just was interested in that.

S Yes, it was, it was something that we, we were aware of, um, that my father dealt with money all the time, um, because he was a stockbroker and therefore it was

the essence to (J. ...) him and his making a living, him making a living, um, but it wasn't anthing that we were allowed to sit down and discuss, or even talk about, or offer advice, or him offer advice to us....

37] JE So, and if you did, presumably you did ask questions about it when you were very young (That's ~~the point~~ right, yes - S) and what happened when you did, can you remember?

S Oh, we were always told we wouldn't understand (uh huh - JE). Occasionally, we were actuallyallowed to go into the office and see, (J. ...) and we were always expected to put on our best clothes but we were always told to sit quietly, and not say anything, just to watch and then, once the visit was over, we weren't allowed to ask any more questions (uh huh - JE) and even now, um, I visit my father very, very occasionally and he's got a big computer in his office, and he'll actually tell me what the computer's for but I mustn't interrupt any transaction that's going on to ask a question or, you know, if I don't understand it on the screen, he won't actually sit down and explain it, go through it or .. because time is money, money is time, and he hasn't got time to explain to me the information that he thinks is going to be relevant to me at a later date, because I'm a woman and I don't understand (uh huh - JE).

JE Is it a woman, or you're a child? I mean which Before you said it was (I think it's very much both - S) uh huh. What about your mother? Does she, is she allowed to ask questions?

50] S Well, no, no. Just the same. Family and business should never mix (uh huh - JE) um, no, my mother wasn't ever allowed to ask questions and it certainly affected her far more than it did us because, as a stockbroker, your home and all your material valuables are on the line all the time (uh huh - JE) because if you make a wrong... if you make a mistake and a bad transaction, and you lose your client's money, then you have to pay up and on a couple of occasions, the family home was under great threat (uh huh -JE), and my father had to bail people out on a couple of occasions, to...

JE Uh huh - what, colleagues of his (yes - S) that had had the mishap happen to them I see, uh huh. (S. ...) So people did stick together (yes - S

[5] S Oh, It wasn't something that family and children should discuss. It affected them, as far as he was concerned superficially, but he was involved in it, so therefore, you know, he was the man of the household and he could deal with it (mmm, mmm -JE). It was quite amusing on a couple of times when he came off with a big deal, but most of the time it was like living under a time bomb (mmm, mmm, I can appreciate that - JE) especially if you don't quite know how the time bomb's made up, or when you don't know

it's going to explode.

JE um ... how did you see his work? Did you see it, I mean, what did you, how, if you had to pick words to describe it would you, what words would you pick to describe his work? I mean, just adjectives, you know, to describe it to yourself or somebody else.

S Capitalist...corrupt...business-like, ..um, mathematical, calculating, devious, unemotional, ..

JE That's quite a bundle of adjectives, isn't it, when you put them all together it makes a lot of links ....[20 secs]..... Right, OK. Shall we, shall we go on. (yeah - S) OK , Hi [Someone at the door]
.... tape turned off .....

[597] Right. OK, so, um, was either of us saying anything (we were going on to the next question - S). Right, OK Can I ask you, do you ever go to a restaurant with a menu like this? This is um, [4]

S Well, yes I do go to a restaurant.

JE Um hum. It's with those sorts of plates, I mean, and, um, and the whole meal sort of added into one price.

S Very occasionally, very occasionally but if I go out to a restaurant - this sounds very snobby - if I go out, I prefer to go somewhere where I'm going to get something special whereby I'm not going to be able to actually eat something that I can cook at home. I don't believe in wasting money.... I guess that's something I've been taught from an early age, not to waste money and so, unless I'm feeling really down, I might go to a Berni Inn but that's very, very rarely. I don't enjoy it. I've also worked in one of these so I know what goes on behind the counter (right - JE) or in the kitchen (laughter).

JE Right. So would you like to choose a dish from that menu. Would you mind choosing a dish from that menu, maybe I should say.

S Right, well ~~then~~ I'd, I'd go for the grilled trout.

[608] JE Right. Now supposing that at this place service is left to the customer.

S So when you take me out that's what I'd like. (S laughs)

JE I see, oh, I see, OK I'll remember that. (S laughing) So, supposing at the place the service is left to the customer (right - S) what would you do about leaving something for service.

S It's usually 10%, isn't it. Usually it's 10%, so now you're going to try and ask me what 10% of £3.81p is.

JE Yes, could you?

S I thought you would (laughter) oh, bless you. Yeah, I could hate you. No, is the answer to that. (both laugh... S laughs) Well, it would be about 38p but I think that's awfully mean [4] for a meal that cost £3.81p, so I'd certainly leave more than that anyway. I don't know what I'd leave. It depends, Soemtimes, well it depends how good the service has been. I might leave 50pence, I might leave a bit more. It depends how generous I'm feeling that day, or how silly I'm feeling. (right - JE)...How extravagant.

JE OK. Does that remind you about any, any things you're, you do these days or ..

S No, I don't actually go out to eat these days, I can't afford it and, again, if ever I was taken out for a meal, I mean, I used to, if ever I was taken out by a meal as a treat, and then it was always the male that was left to deal with the paying of the bill or the tipping unless, of course, I said I was going dutch in which case we'd both sit down and say Oh well, I think we should leave 50p, or I think we should leave a pound or - it was never really worked out specifically. It was always a guess and what we thought would be/an acceptable mean.

JE Acceptable..?

S Mean

JE Mean. Uh huh. Does it remind you of any earlier experiences?

S No. No, not really. Um, apart from early, you know, when I thought I was big and grown up and going out for a meal for the first time and going to the cheapest place becuase I couldn't afford very much. [J: uh huh] Um, no, not really.

JE Where was that that you went? ~~One of these Trust House Forte places.~~

S Oh, One of these Trust House Forte places (J: Right) Berni Inns, (J: uh huh) places that I avoid now as I say, because I've worked in them. they're very good, you can and they're very economical for what they provide and what they serve. They are very good, but I just don't like them.

JE Fine, OK (So please don't take me to a Berni Inn - S) OK. Here's a payslip from Jeniffer Smith and, there it is and she's expecting a wage rise of 9% on her gross pay. (laughs - S) What's the matter? (Oh no, you're wicked -S) I'm wicked, why? [S]

[550] S Yeah, oh God. 'cause now you want me to calculate 9% of her wage increase, don't you.

JE Well, I'd like, yes. I'd like you first of all to say about how much it would be.

S But I already told you I have problems calculating percentages.

JE Well, the first time just say about how much.

S .... Right, well I will then round, oh, I mean, I can only round it to 10%. Logically if I'm going to do it quickly anyway I would do it sort of 10% so if she's earning um, are we doing it per month. (Yeah, per - given, given the data we have here - JE)

[560] S Right. Um .... OK. I presume I'm doing it, the gross amount minus tax and that, (um hum - JE) so the gross amount, she earns is approximately £67 (uh huh) a month so 10% of that, so she, I reckon she'd get an increase of £6-£7 [S]

JE OK. And can you work it out exactly. No, [SE]

S (giggling) No. (OK - JE) No is the answer. I wouldn't know where to start. (uh huh - JE) ... maths horrible feeling ... (yeah, fine - JE)

[568] JE What, uh, does this remind you of any current things or, or any other experiences.

S Well, it reminded me of my wage-slips and when I used to get wage slips I used to always look at the amount being deducted out of my gross pay and think to myself, my God they've taken a lot out this month. I never understood how they worked out the amount they used to deduct but it just used to be a hell of a lot and I wish they hadn't taken it out. (uh huh - JE). Obviously, not now because I don't get any wage slips but actually it does remind me of my grant slip (uh huh - JE) which is laid out in a similar form [S: MNF] but that's money that I get and not anything that's taken away so that's suits me fine (uh huh, oh, I see , you're right, it adds up - JE, oh that's nice)

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S Whereas this certainly, the, I mean you started with a large amount at the beginning of your slip and rapidly the money decreases with deductions, national insurance and superannuation and tax and, you know, miscellaneous deductions and what have you, and by that time you've lost quite a few pounds .

JE Um, um right, OK well, I think that, um, we should probably stop there. Umm, That's all the questions I'd like to ask you. Is there anything you'd like to ask about any of the questions that we did?

S You seemed to concentrate on percentages for some purpose.

JE Um, I decided to take one theme and I took percentages because, um, they're the ones that people most often mention, you know, so, and, uh, I'm using the work of someone called Bridget Sewell who' did this, interviews like this, for the Commission on Mathematics Teaching, and a lot of her questions were on this too, so, and I did make up a couple of my own, but we didn't get to them ~~but~~ and I ~~know it~~ normally ~~might~~ just take about half an hour, so um...

S Are you using other people's research data as well to back up your own, or to add to your findings?

JE Yes, yes, there's, I'm not sure very many people have done interviews quite like this, um. My supervisor, one of them, has worked on girls and maths for quite a while, and she's using some American work which I don't think has been used very much here, so my interviews are somewhat the same as Bridget Sewell's clearly, and somewhat different.

S I mean it must be very difficult to be able to analyse all information that we've got. I mean, when I gave answers to various questions were you, are you looking for the implications behind the answers, i.e. negative feedback about particular answers to be able to ascertain people's attitudes about work? (about work? - JE) Well, about Maths.

JE About Maths. Yes, I have a notion of certain areas where crucial influences have operated and so, but I want you to raise them. I don't want to give you a questionnaire which says how was your father with y'know what he do about numbers. It's more interesting and I think more, more valid when it come up from you. Whether half an hour, or three-quarters of an hour if we've done is enough time for those things to emerge I'm not sure but I think some very important things emerged with you.

[?.s] S Um. I think though, with many people the learning process not only revolves around the instutions, school, but also the helping element and reinforcing element they get from their family (uh hum - JE). Whether the family consider education as a good thing as a means of growing, as a means of getting a job at the end, or whether education is just something that has to be gone through and then progress to a job, and if you've got perpetual conflict in those areas between the school and the family, or between one parent and the other parent then it doesn't help the learning process (um - JE) You know, I feel very strongly about that, especially schools today and the state of the country. You know, even when kids come out of school, they've actually completed the period of inverted commas education, they don't have anything to go to

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(After the tape was finished)....she talked of the importance of the conflict between school and family...(?; see above, p. 15).

In response to the question of how she was feeling about the way she could cope with numbers and maths these days, she said "not very well": she always has her maths worksheets checked by "a mathematician".

In answer to the question of how the course could be best arranged for her or others in the future, she said it should concentrate on the maths needed for the degree, and it should start with pictorial work (see above). Maths should also be put in the context of how it is used.

J Evans - Interview 86/5 (Side A)

026 JE The tape going in the right direction at the time (Right - S [laughs]
OK, we've got the done the hand bit now so, right. OK um let me say that in the same way that whether or not you came to the interview was up to you and if there is any question that you don't want to answer, you needn't.

S Yes ...

JE Good. Um, could I ask you some questions about yourself first. Um, which track are you on, you're on

S Social policy Doing social work (uh huh - JE) eventually but social policy is the package of it (righ - JE)

JE And, um, is that the one you came intending to do? And, um, how old were you when you joined the course last September 1st?

S 28

JE 28.....Right, and, um, where did you study most recently?

37 S Um, I haven't done any studying for quite awhile really. I did, I suppose the last full time course I was on uh, was in Cornwall at the polytechnic there, (uh huh - JE) that was preliminary residential care course [two] years ago (uh huh - JE) when I was sixteen (uh huh - JE)

JE So where was the polytechnic?

S In Redruth, in Cornwall

JE uh huh, so primarily residential care

S It was a two year course

JE And did you use ... how much, if at all, did you use Maths?

S We did have a Maths session but it tended to be um, general Maths, it was really arithmetic, that sort of thing quite simple, not, um, more quick adding up and very/very? various]

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basics, and we did go into, uh, accounts, really on the household side, budgets and shopping and that sort of things

JE To help your clients I suppose.

S Yes.

JE And, uh, the quick adding up you mentioned, was that, um, was that doing that on paper or ...

S Yes, it was on paper but it was somebody asking us questions and we answered them back straightaway so that, I mean I wasn't very impressed with it. I mean I didn't get the impression the teacher was very - he was more interested in boats actually, that's all I can remember about that. I remember we used to talk about the fact that he was most interested

54 in ~~Maths~~ boats (um, JE) he used to talk about his boats and sailing...

JE So you would have a test where you ~~would~~ actually had to add up some things in quick succession and you'd be timed.

S Uh, yeah, I mean timed in that he would ask the questions and give us so much time to answer it and then go on to the next question (uh huh-JE) and/then afterwards we would just mark it, a bit like you get the long books like you get do for children where they can fill in the answers with time out well, it's a bit like that - he just read the questions to us (uh huh, uh huh - JE)

JE Do you have any memories about what it was like doing those tests?

S um, I can remember being quite nervous, I find that sort of thing quite nerve-wracking, um, just just is that, you know, you might not get very many answers (um, well - JE) [you know you'd feel a] fool (um, sorry - JE) - [I'd] feel. I used to [feel a] be the twit and 'cause you were doing it all in a big group, there was a good 12 or 16 of us (yes - JE) in the group so it's, we all had to do it and then we all had to read out the answers

and we used to swap 'round books to work ~~and look at~~ each others
65 as well and that just reminded me very much of school
(uh huh - JE), at junior school (really - JE)
yeah.
...[I see]...

JE Thank you, um What level of qualifications do you have in Maths?

S I did cse Maths. I got Grade 2, at the same time um, when I was sixteen.

JE ... Can you remember whether it was Mode 1 or Mode 2 or Mode 3? Did they have ~~make~~ that distinction?

S [don't know?] I remember being quite surprised I got ~~a~~ it (laughs) I mean, I mean I was very surprised 'cause I remember my end of term re.., marks and report was never very good. They were always C and C+ which at the ~~in a~~ school I was at ~~like~~
76 was average to poor, um, I remember getting the Grade 2 and being quite surprised I was that good and also sort of at the last evening ~~opening~~ in the room the teacher telling my mum and dad that I could go on and do ~~get~~ an [O level?], A level in pure Maths, she never said a word about that to me, I never had the idea that that sort of ~~that I could go on and do~~ Maths (um - JE) I mean, I enjoyed Maths but, um, I never knew that I could do that well ..

JE So what did you feel when you heard that your parents had been told that by the Maths teacher?

S Cross - laughs (cross, laughs - JE) I remember I was really cross because I know my dad used to take great store by your end of term marks and I can remember my exam results were often quite good-thinking about it, they did, um fail, scrape pass, pass, credit, good, very good, distinction levels and I used to get, out of 2 exams, the marks for ~~sixxx~~ 2 exams I used to get things like credit and good and my exam, my exam marks, marks to me were quite good-whereas my end of
87 term marks always seemed to be ~~XXXXXXXXXX~~ quite low (uh huh - JE) and I could

never work out why that was so [always?] just that my father used to take no notice of the exam marks as what you got at the end of term (uh huh - JE). He used to, so I used to dread it. and that always used to be the lowest mark in maths that always used to be the lowest mark.

JE uh huh, thisis in the early years of secondary school (that's right, uh huh - S) (uh huh - JE) and so you'd have exams Once (we used to have them twice a year - S) twice a year, I see.

S It's, ~~xxx~~ a grammar school for girls (I see, right - JE)

JE And then, uh, and then you had the end of term report of course three times a year, is that , yeah you paid more attention to the end of term report, I see. So, anyway now you ~~we~~ know better (yeah - S, laughs.) (Laughs - JE) um, what sort of work have you done most recently before coming here?

S I was working in a children's home in Hackney, I've been there for 10 years as well.

JE Fine, and can you tell me a bit more about that?

97 S [I see] um, in terms of Maths or just ..?

JE Well, just a little more about the work done that ~~at the home~~.

S um, well it meant every day care of the children we were looked ~~looking~~ after, we had "keyworker" system, had various children we were assigned to as such but we had to [?] . It was hoped we would build up a relation ship with them and we took care of their day-to-day things and their emotional needs as well. Um, we were responsible for them in the same sort of waythat a mum and dad ~~parentx~~ would be, take them to dentists, [?] school, going to see [?], meetings, reports , review things that had to be done and then we usually done by the key workers of those children.

JE Right. And, um, did you use numbers in that work in any way?

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S Well, a lot of the children were often quite behind in their work at school and so we did quite a lot of, um, ~~many~~ remedial work with them which would have included maths – quite, in fact we used to do, if the children didn't get homework from school

109 we used to actually do Maths and English with them. So I was [prepared?] to do Maths with them

JE Uh huh, well, that's tinteresting

S Well, it was/~~always~~ quite basic Maths – it wasn't some of the more involved things – it was more teaching tables, and long division, multiplication.

JE So how old were your children, what range?

S They went from 5 to 18 to 22 was the oldest one (uh huh – JE) It's not usual to have someone 22, they went from 5 to 18 usually.

JE Thank you. OK, um, I tried several ways to let people get into to talking about their experiences with numbers and the best way in general seems to be giving you some questions to try Will you be able to do that?

S OK (laughs)

JE um, yeah, I'd like you, for each question, while you're looking at it I'd likeyou to sayfirst of all what things you currently do that [reminds you of?] secondly how you're thinking about the question, tell me that as well if you can and what your answer would be, and thirdly, to I'll ask you what sorts of <u>earlier</u> experiences it reminds you of, feelings it brings up ~~guilt, for example~~. [S laughs] I'll repeat that, uh, those three things each time so. During the time that we're answering the questions I'll just note ~~know~~ what you're saying but at the end if you want to ask me about any of the questions we have some time to talk about it.

119 [S sees].So, here's one. um, this one, does it make you think of any other things you currently do? [1]

S .....The only thing that springs to mind is my ~~history~~ philosophy essay at the moment.

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JE I see, uh huh (laughs – S) uh huh . and what ..

S there's a chart there showing like this, showing um, the numbers of people, the number, the percentage of people in primary poverty section who are within certain sections of

133 that overal section. (Right) Sort of people [over ?] it's got percetange, is showed (yes – JE) each group, showing uh, showing each percentage (right, right – JE) uh .. reminds me of the electircity meter because of the dial (oh yes, uh huh – JE) [?]

JE and what comes up when you think of the electricity meter,

S The bill (laughs) (the bill, uh huh – JE) yeah, it's just, um, because you have to fill in the, the, yeah, if they send you a form you have to fill it in and show where the dial is and I was just reminded of that.

JE Yes, any earlier reminders?

S ...(S sees)......

JE No, OK. um, so if I asked the question that's written at the top there what would you say?

S [?] Households [1]

JE Households, yeah, OK And does this ~~year~~ remind you of anything you've done in your earlier experiences?

S [S sees]...uh, back at school again using, using a chart like that, you know, for a similar question. (uh huh – JE) [It doesn't come up with?] anything specific – it's just taht it's a good way of showing how something like water percentage could be divided up between the people using itand using that obviously other things like electricity

JE What, about what stage of school would that have been?

S .. Don't know Can't remember

JE That's fine. I'm just interested in whatever comes up, (S Yes) whatever you see

S (laughs – S) [Can't think of anything else.]

JE Fine, thank you. Here's, uh, here's another one. What sort of things ~~do~~ that you do currently does that remind you of? [2]

S .. um, I suppose working out how to get 10% of something, in ~~a~~ a shop, working out, you know, the actual cost, how much you'd get off (um hum - JE) ..apart from working out 15% 95
I can never figure out what, the only way I can actually work out 15% is to do 10% and then half it and add the two together to get 15% (uh huh - JE) and that, I know that must be - there must be a simpler way of doing it - quite a long way 'round of doing it I just find that quite easy way, y'know

JE um, and you do that for, you do the 15% calculation for ~~year~~ - (S: VAT) for VAT. Do you find you have to calculate VAT very often, these days?

S Not really. I can remember doing it, I think I remember doing it with uh children's work at the home actually (um - JE). They actually get set questions on that
173 - and thinking to myself (um, JE) hang on, that's, (uh huh - JE) yes, and working it out so that I can help them out with it [3 sec] Again, ~~with~~ it would be sales as well, sometimes I give ~~the~~ a 15% tip as well, though it's usually 10% (um hum - JE) ...[6-8 sec]...

JE So, how, how wouldyou think about that one, what is 10% of ~~61.01,~~ 6.65? [2]

S [5 sec] .. uh ..(slight laugh) 66p. 66½p if it: ~~was~~ pence

JE Fine. Thank you. Does that remind you of any earlier experiences?

S I ~~think~~ didn't like these things very much at school, and I didn't
185 really like percentages - percentages were so, (cause I could do the usual multipying, multiplying with decimals, with ~~but~~ the division, but I found percentages (uh huh - JE [I didn't like?] very much

JE What comes up when you think about percentages?

S Just uncomfortable, because you get, I'm never quite sure

whether or not ~~I'm~~ it's quite right (laughs) (uh huh - JE) I suppose, of the actual method of doing it, something, percentages - [I just haven't got that?] I ~~never~~ can remember ~~being,~~ an uncomfortable feeling

JE What, um, do you recall any particular experiences when you think about percentages?

S Not really, no, .. No, not really, I just remember being uncomfortable with percentages ....

JE Right, thank you..... Does that make you think of any other things that you currently do? [3]

S ..We've ~~not grasped~~ done a lot of graphs this ~~at all~~ term (uh huh - JE) [5 laughs].. [5 sec.] in [?] (in um? - JE) in Methods and Models (right - JE) ... (this particular term, this past term? - JE) no, in the past couple of ~~other~~ terms really, the whole year (uh huh - JE), yeah (righ - JE) .....

208 JE OK, ~~the~~ any, anything else?

S I don't remember being uncomfortable or particularly keen on graphs, actually, I don't know - I did then, but [I don't remember anything (?)] (um hum - JE) I, I think I've - um, ~~Ixxxxxxxxxx,~~ over the past couple of terms I've learnt more about graphs than I actually knew, I think (uh huh - JE) because quite a lot of, some of the terminology, ~~is~~ and some of the things you can do. I wasn't aware of - I know, I'm sure I I wasn't that I just forgot, I don't think I actually knew. I found it quite interesting, I quite like learning new things to do.

JE .. and was that relatively, was that a rare experience for you, say, in the last three terms that you learned something that you hadn't known before?

S um, yeah, I think it was actually. I think partly because a lot of the Maths ~~I'd~~ been doing had been stuff that I already
220 knew, that I had to know to help the children (yes - JE) and so, and of course a lot of the work they were doing, junior school, secondary school, so I would have known that anyway, (yes) quite a lot of it. There have been things that I've forgotten that I've done how like , and I had an argument with another member of staff about sort of · well, disagreeing with him about whether

not you do it in such a way (uh huh - JE) but I don't, I mean graphs, I mean -you know- they're OK (uh huh, uh huh - JE) (laughs - S)

JE What was the outcome when you had the argument with the other member of staff?

S It was over logarithms actually. That's the one that springs to mind - and I was right (laughs - S) (uh huh, and you - JE) I was quite pleased, I, 'cause I knew I was right 'cause I love working with logs , I love messing about with tables (yeah - JE) I really enjoy that. (uh huh - JE).

JE [6 sec] When did you, when would you last have used logarithms for example?

S Oh, that would be years ago. [2-3 sec] That's was when I was helping a girl do her work , I think, that would probably have been [five ?] years ago (uh huh - JE) and I would not have used them a good three or four years before that.

37 JE Right. She was doing them at school (yeah [?] - S).... Right, so, um, questions there, um, which part of the graph shows where the price is rising fastest? [3A]

S um ....it's the .. just under 600, [up to] 650

JE Thank you. And, uh, what was the lowest price that day? [3B]

S [?] .....(laughs) ...(can you say what it is? - JE) ....[6-8 sec].. ... five ninety ? (JE) ..[3 laughs]..

JE Yes, we can talk about any of the questions that you want to afterwards. um, does it remind you of anything earlier, any earlier experiences?

S ..[3.5 sec]..No.

JE Right. Thank you..... um, I wonder if, ah, do you ever go to a restaurant with a menu anything like this? (S: Yeah) And could you choose a dish from that menu? ..... Something you'd like to ... [4]

S ... All of it, actually. (laughs) laughs - JE) I think I'd go back three times, I think, to have one of each. um, the seafood platter. (uh huh)

JE Suppose you'd had a meal in this restaurant and the service - the amount of service that you leave is left up to the customer, what would you do?

S I think a lot would depend on how much the final bill came to. Perhaps I would round it up to a whole £1.00 or I think

27L it just dpends on how much it came to

JE Right, umsupporse it came to something like £3.80.

S I'd probably leave £4.50 or something. I mean when I say round it up to a £1.00 but I would probably leave a certain amount - It would depend on how much change I had in my purse, whether or not I was paying by cheque and what the service was had been like. If the service had been good I'd be more likely to leave sort of up to a pound, perhaps more, just depending really but, um, if it was not a particularly good meal and I didn't ~~'d really~~ enjoy it, I might not leave anything really, or only a little.

JE um hum, when you say leave up to a pound you mean a pound in addition to the £3.80 (S: Yeah) or or up to £4.00 in total.

S: Well, if the service was goodand it said £3.80 then I might say leave um, just a straight £5.00 if I'd really enjoyed it, and the meal was good and [?] Just round it up to, I probably wouldn't think of leaving 10% actually, or 20% - I just, and it would also depend on whether I was with someone, and we might ~~could~~ compare notes as to whether or not we thought it was good enough to leave a good tip or not such a good tip.

JE Supposing it, um, What would a service charge of 10% be on say, that meal of 3 point, £3.53 ?

S [11 sec] 35p [4]

JE Thank you. Does that one remind you of any, uh, any earlier experiences, something like that?

S ...uh, [8 sec]..I suppose, I can remember a time when the service charge seemed to be always included, and you didn't have to think about what you were going to leave extra for the service charge (uh huh - JE) and then can remember thinking

300 what on earth [bought] - what on earth shall I leave if they haven't [done the thing?] and I actually went over to thinking, um, well, if the service charge is included who, who is that service charge going to (yes - JE) and I can remember more recently going to a restaurant and asking that, and ~~yet~~ finding out the person who'd served us was only part-time and so never got any percentage of the service charge which was set aside for tips because he was only part-time, and I remember pursuing quite an argument ~~thatxnight~~ with the manager about it because I thought it was very unfair (uh huh - JE) and the man wasn't allowed to accept the tip either which I thought was ridiculous (um -, that's very interesting, that's not what I would expect, without asking JE) I don't know what made me think of it. I, I know, I suppose the whole thing about service, service charge has [come?] - this was quite a while ago, I think I just used to wonder (uh huh JE) who got the service charge, and was it a tip for the people who were doing the waiting or was it, you know, shared out amongst all the staff, including, say, the cook or something like that or was it just profit, I mean that they got extra. Sometimes I get a bee in my bonnett like that, check up, I don't say that I always do it, but I do more often than not I'll ask ~~what~~ who are these service charges for.

JE That's a very interesting argument that you uncovered in the other case (I have - S) I have never heard that one before)

S I hadn't heard that argument before either ~~Ixxdxnexexxhexrdxitxbefexexeitkexx~~ and I hadn't a clue that part-timers wouldn't get part of the service, because if they took all the service charges that had been in for that

evening that worker ~~had~~ hadn't been there working that evening

325 I couldn't see any reason why they ~~that worker~~ couldn't have a share in that (quite - JE) but they didn't -

JE Right, thank you. Is there anything else comes up.....?

S No...... [5]

JE It's a, have you ever received a slip like this?

S Oh yes.

JE Um hum, looks familiar eh (S. yeah) but uh, in what contexts?

S uh, reminds me ... of ~~when I've been at~~ work.

JE Uh huh, in the job you have.

S Yes, I've also started working in a shop at the moment so I have another pay slip (uh huh - JE). This is a good pay slip. It's got everything listed out all the payouts and all you get, you don't get that with Hackney Council, that's for sure (Is that right, - JE) um, you get all these odd little code things every now and then and suddenly a bit extra you don't realize, if you don't know what it's for, you get a bit taken away and you're not quite sure about that either. (um - JE) Forever phoning up the finance people, and asking what it's all about [? see].

JE Does it remind you of anything else?

S Just, I'd immediately look at all the usual things like tax code, how much I've paid already and how much tax I've paid (um hum - JE) um, that sort of thing.

JE You would check the tax code (yeah - S) Yeah, so you normally knew what it was when you (S Yes) Yeah ....

356 S And of course, the amount you get at the end [laughs] and check that they'd taken away the deductions properly ~~for~~, yeah (yes - JE)

JE Did you find many mistakes?

S Not very often. I know once they took away, I remember I got a pay slip for about £50 for a month and what they'd done is taken away some huge sum , whatever, they'd taken something away instead of adding it - I nearly had a heart attack! £50! (laughs) Oh God, That was dreadful, that was probably the worst payslip I ever got I think (um - JE) but they were quite good about it, I rang them up and they said it was a computer error and they would send me a cheque to cover the rest.

JE So you never hesitated about ringing up about it?

S No, (no - JE) I used to phone up and find out what was going on (uh huh. uh huh - JE) Well, you never knew when you were supposed to be sleeping in allowance, 2-3 nights a week (yes - JE), and you never actually knew, when, in your payslip when, when that money was being paid for. ~~And it~~ So that was always a bit behind so you never knew in what month you were going to get it for, there wasn't a date next to it or anything like that and if you were expecting extra because say you'd been on holiday with some children or something, then you just had to keep your eye open for an extra amount and then just check that that was for that particular month (um - JE) / But sometimes, if they were short of staff, it could be months behind, and, like, you'd be trying to catch up forever. It was very difficult to work out from those payslips what was paying for what, I mean abexxtx, apart from the basic pay and the London weighting, anything extra was quite difficult to work out. I think overtime was separate but the rest was sleeping in allowance, and something else - It was just really difficult to work out what on earth was ...... I could never understand why they couldn't just print what, what it was you'd got because I was sure that the computer was clever enough to just print out what that payment was for [?] (um - JE) ....

JE ~~Gosh, you'd~~ I should think it was.

S Payslips were frustrating, I've decided (laughs) [?]

JE uh huh, why do you think that is? I mean are/you thinking about what you've been telling me in connection with Hackney or something?

S Yeah, with Hackney definitely - the payslips were just dreadful (um - JE) in terms that you don't really know what's going on all the time unless you're willing to phone up and check. and the man at the other end is quite pelasant, always quite helpful. If you had someone who wasn't very helpful, it would be awful trying to sort out what on earth is going on

399 JE What about your current job? Is that a more helpful set up?

S I've only had two, but uh, I don't pay tax, 'cause I'm a student so that's OK. There's a couple (laugh) of things on that, that I've actually got to ask about this week. A couple of initials and a reduction, I'm not sure why, (uh huh - JE) they've been deducted. I know that insurance will come off but I'm not sure about the other thing, so I ~~'m going to~~ shall have ask them this week.

JE Thank you.um, suppose Jennifer's expecting a rise of 9% of her gross pay ~~a year~~ here. Approximately how much will that be? [5]

S (laughs) um [3 sec] on her gross pay [6 sec] 10% will be £6.5 .. would be something just under £6. I should think

JE uh huh, right, that's fine and can you work it out in exactly?

S Not this minute

JE um, not, this minute, um, why not?

S (laughs) I'd find that quite difficult. I'd really ~~need~~ have to wrack my brains to answer it properly, it's the percentage [business?]

421 again (uh huh - JE) ..

JE How Would, you, how would you go about starting to think about it then?

S uh [10 sec]........I think I'd just have to try and remember how Idid it at school.....

JE What would, what would come up when you tried to remember?

S What, how, how would I actually do it?

JE Yeah, what, what things would you remember?

S [Yes]. something to do with insurance. (uh huh - JE) something to do with, um, the figures times possibly more over a hundred — I'm not sure (uh huh - JE) I think I'd have to ask actually (uh huh - JE) or look it up in a textbook (right - JE)

JE um, do, there's some paper there if you want /.. no (laughs) no! S) What, do you have a textbook you could look up that particular thing, access to it at ~~all~~ home or

S Yeah, ...having said that Idon't think I have , I could have done, the children"s home, I could have looked in one of their books and we also had books that we used with the children (uh huh, in, in the home - JE) Yeah I always feel much easier if I go and can look something up and check it (yes - JE) than just try and guess if I don't really know. I feel much happier ~~when I'm~~ about checking something (um - JE) which is why I wouldn't do it now, [S laughs]

JE If I wasn't here, you know, if Ijust disappeared out of the room, would you do it then? Supposing somehow you agreed that you'd do it by tomorrow morning, um, and then I said thank you very much and good bye , uh, would you, how, what would you do then if you decided?

S I'd probably attempt to do it the way I thought it might be done and if it came to a figure that I thought might be might be reasonable then I would probably leave it at that and then go home and check it in something (uh huh - JE) ... but I wouldn't tell anybody ~~that~~ about it, until I'd checked it (I see - JE) to see whether or not it was right (uh huh - JE)

JE And that would include not telling me?

S yeah, (Laughs)

JE Why, why is that?

S I don"t, I'm just thinking about why that was. I'm not sure but I think it might be to do with , um, with when we were at secondary school we used to be divded into houses and we used to be able to get house marks and in Maths in particular if we got so many "goods" then we would get one house mark and I think it was to begin with to get one house mark you had to get 4 goods, to get two house marks or a second housemark you had to get five goods, so it went up a little bit each time until you got to six I think and then every time you got six "goods" the teachers would count them up and you'd get a housemarkand that all went towards — so it was like quite important to get things right (um - JE) and that included in homework as well

JE So how did that effect the way you went about questions?

S [I see.] um, things that I was quite confident about I'd just ~~used~~ ~~to~~ get on and do, but something like this which I was never very [confident] ~~comfortable~~ withI"d sort of flounder ~~xxxxxx~~ about.I think I'd find them quite difficult to do as homework as well. partly because there wouldn't be anybody to ask, at home, (right - JE) Yeah, homework you're on your own (uh huh - JE) unless you've got somebody right near by who can give you a bit of advice or/ a book ~~that~~ you can refer to, then you're stuck if you don't know what you're doing (right - JE) and I used to feel like that quite a lot when I wasyounger and if I didn't get it right my dad used to shout at me [']. (uh huh - JE)

JE I was going to ask would your father or mother or brothers or sisters have been any help?

S Well, I was theoldest (uh huh - JE) and I went to grammar school and the others all went to secondary modern schools (right - JE) that set me above them anyway and I was supposed to know how to do these things, um, and my mum was never

564 very good at maths and my dad, he had quite a good head for figures, um but because I went to grammar school he expected me me to know and if I didn't he used to tell me off (uh huh - JE). and as far as he was concerned I hadn't been listened in class in that case and I should know, so it was easier not to ask him for help because then I wouldn't get told off (yes - JE)

!!!

JE And did you not have mates nearby ~~the~~ from the school?

S um, it was quite difficult actually because I think my dad's attitude to the homework ~~question~~ was sit down and do it and get on with it and, um, he didn't really agree to me taking it/round other people, I don't remember him being, no, when I was younger it was a case of getting on with it. As I was ~~getting~~ got older I used to tell him that I did a lot of work in the free periods at school so he assumed that I didn't have a much work to do because I'd done so much of it and I used to go round to a friend's then - a sneaky way to do it... I didn't often get together with friends and do work: We used to get on with it and then compare afterwoards. There were, you know, it was a bit awkward 'cause,um, 'cause I lived in a quite small village and out of about 15 of us, only 4 of us went to grammar school, one was a boy and so he went to the boys' school which was very different. I never really saw him very much afterwoards.

JE Everybody ... sorry.

S Sorry. One, one of the, one of the four of us was a boy and he went to the boys' school so we didn't, I didn't really see him very much after that and the two girls lived further away from me. ~~And~~ i.the other friends that I had

were actually at secondary school (yeah - JE) or were at school with me but lived in town which meant that I couldn't and we didn't have a phone ~~it~~ then so I couldn't so in fact there wasn't many people actually around that I could get in

542 touch with (right - JE). I only realised that now

JE How did you find it here then , did you do any work for example with other people in Maths at college?

S um, um, I think surprisingly and pleasantly surprising I found that I could do quite a lot it and actually needed to help quite a few other people (uh huh, I see - JE) partly because quite a lot of work we did was a case of having a formula and putting it to certain questions/and working it out and I love that sort of thing (um hum - JE) I mean, you know, somebody gives me a way of doing something and then says you've got this bit now go and do it, I mean I love doing that, the idea just the sheer pleasure of doing that is just really very nice (uh huh - JE)

JE Could you say a bit more about that, maybe give me some examples?

S um, Some of the long formulas in the current worksheet - with sigma (x) and everything - I mean that, I just really enjoy, I mean, I needed a calculator obviously but even so I really enjoyed it, doing that sort of thing.

JE Right And any other earlier experiences come up (S: um) when you're thinking about that?

S Just, um, logarithms again, ~~cosigns~~ sine and cosine then & sorts of ~~and~~ things, tables, [messing about this and that] I suppose because the numbers ~~are~~ were there in some way and that sort of ~~gives~~ gave me confidence to get on with it (right - JE). I used to enjoy binary numbers as well, I can remember doing that - [I'm remembering all this - I haven't thought about this until today! - ah pleasure] but um, and I used to enjoy geometry, and ...

because you've lots of theories then, I mean, you need to work out 1 angle if you had ~~, and~~ something else and I
584 can't remember any of the theories except Pythagoras and that (right - JE), that one was like drummed in, remembered but, um, I remember we used to have a book ~~with~~ with geometry theories, we just lookedthem up if we wanted to do our hoemwork, and I used to really enjoy ~~ed~~ that (uh huh - JE).

JE You had a book with all the theorems listed there?

S Well, what happened was we had an exercise book and the teacher used to go through a different theorem with us and get us to copy it down neatly, and then we'd have an example plus the actual written out thing from before

JE uh huh. Thank you. Right, well I think that's probably all
600 the questions I want to ask you now, um, Is there anything you'd like to ask about any of the questions?

S Apart from [?]- what's right. [laughs]

JE That's fine. Let's look at that. Which one?

S Any- Well, from the beginning [laughs]

J OK No. 1 You said ## and that's right because that sector's [1]'
bigger than any of the others. And No. 2 [2]'

[No. 3] [3]'
618 JE ...before lunch, at that time of the day, that's right
and ... £5.90 which is right and, uh, number 4 you said [4]'
35p and that was 35 and number five, um, you said about, you said around six [5]'
pounds which is right and, uh, you had the right way to do it (S - Ah - that's interesting). you said, what did you say? you said (I said the figure times - it was 9% wasn't it? - nine over a hundred) um, yes, percent means over per a hundred so that's fine. I mean, and you could just go ahead with it

S It's really odd how I need to be reassured that I'd done it right (uh huh, JE, uh huh) and I'm sure that items from years ago, I'm sure it does - not having the confidence, I suppose

JE Right, and why do you think that was? (um - S) that you didn't have the confidence?

S I think really that it might have been because the teacher just didn't say, that, you know, yes, well done you can do this, you know, (right - JE). I was inI think, the second to bottom set, they had five sets and I think I was in the 4th set for Maths and though I didn't think I did particularly badly the end of term marks always were what I felt was quite low (yes -JE) although average ~~d~~ to poor wasn't too bad. I mean given the marks I used to get in the exams and I can remember doing
633 maths and ~~even~~ finishing it half way through the exam time and (really? - JE) and panicking like mad, thinking: How could this have happened? and going back through everything again and then just deciding - well, it must be all right and if I start Istopped fiddling about with it and I can't do any more then, if I start fiddling about with it I'm going to get it, mix it up or something so I actually left something like a half an hour before the exam ~~xxxxxxx~~ finished and ~~it's~~ I sat waiting for ~~happened to~~ two of my ~~xxxx~~ friends for some time - and that really worried me, I [laughs] mean, you think, oh my goodness, you know, I really messed

it up when I didn't at all (um - JE)

JE So you'd done it fine and you were right that you'd done it so. Good. And how did you do on Maths in the first two terms?

S Um, Ok, not brilliantly but OK (Nodding) I was quite pleased.

JE You know, you know about what you got did you? (Yeah, yeah S) to the nearest 10 marks or so, (S: ohh, I can't remember now) but it was fine whatever

(Yeah - S, There were a couple of things that I was a bit weak in, that I wished I'd done better in but Icould see where I'd gone wrong and there were all sorts of things that I could kick myself for, I should have remembered.

JE um, so you do have quite a lot of reasons to feel confident in maths now.

S [laughs] Yes, I mean, just helping other people made me realise that I think I wish I'd known I could have done O level/and A level and gone on. I wish I'd known that from the beginning 'couse then, maybe I would have, my attitude towards it would have been different I'd have been more confident, maybe I would have achieved that bit more, and maybe I could have moved up my groups and actually done A-level - that, at the grammar school you know, Ijust wish she'd said, wish she'd told me. I remember that the first thought I had was well, why didn't she tell me that, why did she wait until the 4th and 5th year and tell my Mum and Dad that (um ' JE) why didn't she say that to me years ago, because I'd had her for something like the 3 years out of the 5 and, I mean, I always thought she was quite a good teacher, I mean she was quite clear, she explained things quite well, I mean, you know, the thing about the geometry theory book I thought was quite good, at the time but looking back on it with the experience I have with the children in the children's home and the sorts of teaching they got, um, I remember thinking well, my teaching wasn't that bad at all, y'know it was quite good. but why didn't she tell me, why didn't she just

say to me, (um - JE) you can do this, that was, I mean, I realized that was all I really needed then - I didn't know that at the time, but it would have been helpful.

JE Well, you, you know now that, uh, even though she didn't say ityou were doing well so it's nice to know Good, good, um How do you feel, this is a sort of summing up question, you've said something about that already. How do you feel about the way you're able to use numbers these days?

S um, I think it, I just I've ~~I have~~ learnt a bit from these past two terms. There are some things that I didn't know that I felt that Ireally should have known and that I'm quite pleased that I've learned. I think, also, um it's just made me aware of it again, and that that's quite nice - it's like - it's funny actually, I was saying in the Maths Seminar that I'd find this term a bit boring (um hum - JE) and at one point, he was doing, something, I wasn't talking about maths, I was talking about the term itself and he did something on the board and said, oh it's all very boring really, and I said, so, it's not, because it actually, it set me thinking, it was as if something had started up again and I, I just quite liked my brain to be moving, felt as if (uh huh - JE) getting somewhere and I like to think about (sure - JE) something, do something and I find it interesting, so- and I do find Maths quite interesting (um - JE) especially if I actually manage to grasp and see the light, and say Oh yeah, (laughs) that's really nice (um - JE)

JE And what was it that he was doing? Do you remember?

S It was probabilities (uh huh - JE) which I don't remember doing very much about at school (right - JE) I don't remember very much about probablilties at all and I feel as if I've learnt quite a lot from that. I'm sure it was probability

672 It was a few weeks ago (uh huh - JE) ---

JE Right, um, is there anything you'd like to say about the way that the interview took place?

S No, it ~~is~~ was fine actually. It was more relaxed than I thought it would be and I'm glad there wasn't a good pressure ~~extra~~ to do (um um - good JE) Nice to talk about things (yes - JE)

JE Yes, I mean, those are, a way basically to give you a chance to talk about ~~it~~, about your experiences.

S It's surprising how many memories came up (yes - JE) that I'd— obviously ~~hadxax~~ don't think about all the time but they're obviously there (right - JE)

JE Yes, yes. I noticed that um, I'd like to ask you, of course, not to discuss the questions with anyone else on the course or, indeed, the fact that there were questions, just so that people won't come to the interview with any preconceptions. (S: right) OK. Could I ask for your permission to quote things you've said here in a suitably anonomised form, of course, (S: yeah) in things I may write in the future (~~Yes~~ Sure - S). OK um, I'm aiming to have the transcripts of each interview tyyped up and it may take some time, of course, but when I do I'll offer you a copy of it and also a chance to talk to me further about things that have come up during ....

S um, yes. That would be nice

JE (S: Thank you) Anyway, thank you very much. And I appreciate you're coming in on a sunny day, and uh, I've uh ~~and everyone's come~~ this year (Oh good - S). I think I, last year there were a few no shows and I don't think I was so well organised, but - so it's very nice that everybody comes to ~~o~~ to talk about Maths even in hot weather.

S Well, I do find it interesting, and I was interested to see what [it was .]

JE Yes, yes, well it's interesting for you to see how I would conduct an interview on this area. You know, it's useful for research methods (that's right - S) and so on. Right anyway, thanks ..
All the best to you and see you next year, if not before. (Bye) Bye

85/7 J This is to give you some space to talk about your experiences with
TALK II numbers and how you feel about them, um, and the way, as the way to get into this I'd like to give you some questions to try and then to talk about while you're trying them. ok? (S: inaudible) Um, there's, right, here's some paper for you and some paper for me here um, now first of all can I ask you some questions about yourself, um, how old were you when you joined the course in September?

S: Twenty

J: Twenty, right, umm, last September? And where did you study most recently before coming here?

S: Er, Redbridge Technical College

J: Redbridge, uh huh, and, what sort of things were you doing there?

S: A levels in Psychology, Sociology and English Literature

J: Uh huh, and were you there for a year or...

S: Two years

J: Right, how much did you use maths there?

[40] S: I used a fair amount for psychology, well, statistics, statistical tests and um there was a little bit in Psychology, er Sociology rather

J: What kind of thing did you do in soc.... sociology?

S: Umm, mainly looking at, can't remember now, its very similar to what we did in the last wordsheet, (mm mm) looking at reliability validity of certain surveys, results (mmm - would that be...) it was a small amount of that, not a lot.......

J: Was it, would it be like um you mean worksheet three or worksheet four?

S: err - probably more like worksheet four or perhaps a little bit more like the philosophy like Lockwood and Gold.......

J: Oh, yes, Goldthorpe

S: We looked at some of those studies and analysed it, both for sort of mathematical and philosophical [inaudible]

J: uh huh, oh good good. Right, um what level of qualifications do you have

in maths?

S: Umm - I've CSE Grade two (hmm hmm) I attempted O level but I got an unclassified

J: Uh huh, right, what does that mean, what does unclassified mean, does that?

S: That means I failed it completely

J: Oh really, Oh does it?

S: Yes

J: Oh I see, right

S: Terrible (laughs)

[Interruption by someone at door]

J: OK, um right, and what sort of work have you done most recently have you done any summer jobs or did you work between school and college?

S: After Redbridge Technical College I took a year off where I did work in, with a drugstore for about six months and I was involved on the till and sometimes it involved taking money to the bank as well

J: Right

S: That was about it, just adding up taking away

J: Uh huh, so ok,....... .er..............................right, ok, thanks, so um now I'd like to ask you to take a look at a few questions that I've got here ok so,(S: agrees) for each question, while you're doing it I'd like you to um tell me if it reminds you of auy other sort of tasks that you do in your life these days, and secondly, I'd like you to say as much as you can about how you're thinking about doing it and um, also er give me an answer if that's appropriate, and er, finally I'll ask you what sort of earlier experiences with numbers it reminds you of and any feelings it brings back, so, I'll keep reminding you of those three things and during the time that we're doing the questions I'll just note your answer because I don't want to interrupt you by discussing the questions but at the end we can take some time to discuss any of the questions that you want, ok? Umm, and I also want to ask you of course not to discuss these questions with any other people on the course because that would mean I couldn't use them with them (laughs) - ok? So, here's a pie chart - looking at it which do you think uses more water, er, households or industry with meters?

S: Households

J: Uh huh, ok, does that remind you of anything else you do these days?

S: Umm, not particularly, no

J: And does it bring back any....does it remind you of any..........

S: It reminds me of earlier maths, uh, concerning my feelings about maths - I'm - it's very neutral - I don't have any strong feelings about maths. I have difficulties in maths, but um, and I can't concentrate for too long on maths I have to stop after a while, cos it just doesn't - I just can't stick at it and I don't have worries about it, I just stop and then have another go later on [laughs?]

J: Right. Umm, yes why is it that you can't stick with it - do you - what comes up when you're

S: Usually when it's just studying maths it is...in an abstract way it's not usually, when I have studied it's not usually related to something that I want to know. Say, for example, psychology -I cope with the maths because I'm interested, I want to find out something through, via it, therefore I'll stick ~~with~~ at it a lot, lot longer than just maths on it's own (hmm hmm) and even doing maths as a separate subject, it doesn't appeal to me, I can't stick at it (hmm mm), and [?...] if I need it I'll just use it (Right, right) but otherwise I just don't want to study it as a subject.

J: And have you always felt that way about it?

S: Um, yes, (hmm mm) That is to say, I don't find any intrinsic value in it......[3 sec]......therefore I feel however good someone is in conveying something to me in maths it doesn't make much difference because the
[170] subject isn't intrinsically [inaudible] interesting.

J: Ok, right and you felt that even at Primary School, did you?

S: Umm, I didn't think in those terms, it was very mechanical my mathematics it was just I've got to get this work done therefore I'll do it and it was a mechanical without any understanding, or not much (hmm mm - and that's....) just get it done, get it out of the way (right), and then carry on

J: And have.......and you felt that as long as you've been.......

S: That's as long as, I mean even here, the maths worksheet, I've got to do it, I'll get it done, I'll get it out of the way (right) and that's it, that's how I feel about it, I don't sort of find any enjoyment in doing it on it's own (right) but in psychology, doing statistical tests now I like to do it I like to find out the end result, see what it means, as in relation to my psychology

J: Right. And you're doing psychology track, right, and are you already doing some stats, some separate stats outside of methods and models with
[200] them? (yes) uh huh cos you're doing labs already this term?

90

S: Oh yeah, we're doing things like related t test, unrelated t test, Wilcoxon tests (right) sign [inaudible] test,...........standard deviations as well

J: Right, ok, uh, what, what, you say it reminded you of school, what time at school did it remind you of?

S: Um, O levels and CSE's

J: Right, you had those kind of things

S: I think more CSE that O level

J: And within those did you, was it still pretty much what you were just saying about maths or did you find pie charts, for example, any different from the other sorts of maths in anyway?

S: Pie charts, it means probably a lot more than just figures or letters, so, yes, it was more meaningful that other figures

J: Right, so, shall we look at the next one? Oh, sorry did you want to say something else? R

S: No, that's fine

[2] J: So, here's another one, what's ten percent of six point six five?

S: er.........it's point six six five [2]

J: Thankyou. Does that remind you of anything, anything that you do these days?

S: [5 seconds] Perhaps if I want to know interest on my bank account (hmm mmm) I'd think about it in those terms, or if you get ten percent discount in shops on certain items.............I'd work it out

5.

J: (right, uh huh) Does that remind you of anything as school? Anything earlier, rather

S: Only that I did percentages at school, that's it (yea) sorry to be so [inaudible]

J: No, its fine, its fine, clearly there are no right answers or............to this.........its just what comes up for you

S: Except if you'd given me say, nine percent or eight percent, er I would probably have to think again how to work out percentages, probably have to go into a book and it out how to work a percentage again. As it was ten percent I always know you just move the decimal point, and therefore.......

J:< (uh huh) So that's how you did it

S: That's how I did it

J: You moved the decimal point, and how did you (S: the decimal point) and how did you know (S: to the left) how did you know which direction or.....

S: Umm, well I knew it's going to be a smaller figure, so I knew which direction it ought to go (hmm hmm, right) I knew it had to go one decimal point because it was ten percent, if it was one hundred percent..... ....

] J: Right, right. Right, ok, thankyou. Here's a graph which shows how the price of gold was changing in one day's trading, um...., two questions about it - which part of the graph shows where the price was rising the fastest?

S: Er..................[25 secs] here

J: So, the last part of the first half of the day. OK. And um what was um what was the lowest price that day?

S: The lowest price was um......................[sec] five ninety, five hundred and ninety [3

J: Yes, thankyou

S: [Dollars, pounds? (for ounce. per ounce)

J: Dollars, ~~pound~~ per ounce, sorry. Right does that remind you of anything? .... anything you do these days?

S: Not particularly, no, ~~I'm afraid~~ (I'm [illegible]) I wouldn't use that, wouldn't look at it, wouldn't be interested in it (uh huh) unless I was interested in gold (laughs) (J: right)

6.

J: Uh huh - does it remind you of anything at school?

S: [4 sec.] Just doing graphs

J: (uh huh, right, right) What would, what would you do if say you were interested in gold but you couldn't read the graph? How would you? [[illegible]]

S: I would look up text books. I'd find out, I would ask if I was sufficiently interested in the price of gold or the value of it, I'd look up [investments] and find out about it.

[4] J: Right................ .... [8secs] Right, ok, um do you ever go to um to a restaurant with a menu like this?

S: [5 secs] Not recently, but I have been, yes

J: Umm, what would, could you please choose a dish from the menu?

S: Um, Chicken Maryland [imitates American accent] [23.75]

J: Chicken Maryland, ok, and um what would, suppose service in this place was left to the customer, what would you do about leaving something for the service?

S: for Tips?

J: Ya, well, for service, supposing they said service was left to the customer

S: Do you mean, I don't understand that, do you mean self service?

J: Umm? It's sort of service charge. It's like a tip (S: ok) except in some places they call it service, because it's left for the people that serve you

S: So you've got to pay them separately?

J: Well, you're free to leave soemthing separate for them if you want to, suppose, it just said at the bottom of the menu, umm, no service charge,

[3.42] left to the customer to decide, it's like a tip, ummm.......

S: But you decide how much you're going to give?

J: That's right, yes, yes, so it's like a tip in that sense.

S: So [its up to?] you to give at least something

J: Yes, yes, in this restaurant they say at the bottom 'left to the customer'

(S: yeah) What would you normally do about that?

S: Well, II think that a normal tip, what's conventional, is about ten percent (J: uh huh) so, if I decided I was going to leave a tip, probably, what? ten percent would be thirty seven and a half pence, so I'd probably give 40 pence just to round it off [4

J: *Hmm hmm, um, how would you decide* if you were going to give a tip?

S: My criteria? Whether I had enough money first (uh huh) secondly, whether it was good service - if it wasn't good service I wouldn't give a tip - well.........................yeah, probably. I've never felt obliged to give tips. (laughs) When I feel like it sometimes.

J: Yeah, I'm interested in how you decide about that but er.................right................er............what were you going to say?

S: It would depend on the [nah..........] there are lots of factors affecting whether I'd give a tip or not could be lots of reasons

J: Yeah - *are there any others?* You mentioned if you had sufficient money and whether the service had been good. Umm - what other ones are the most important factors

S: That's it, I think

J: Uh huh, right...right.....ok does that does this remind you of anything of any past experiences or........................

S: Just going to restaraunts

J: *hmm hmm*

S: [8 seconds] Otherwise it doesn't remind me of any particular experience

J: Any *ummm* - I was just listening to my colleague talking about how much she's marked in the last few weeks[............umm yea, any experiences in restaraunts stand out? or...

[39o?] S: No. .... maths doesn't evoke much for me! (laughs)

J: It doesn't, no This is a little bit.......... this is not just the maths, I mean it might evoke experiences that aren't mathematical, so er, I'm interested to hear about those if any come up..........................right, ok.....um.................here's someone's payslip, from er someone called

[5] Jennifer- *get these out of your way- Smith, and here's her payslip* and er

she's expecting a rise of nine percent, er can you tell me first of all about how much that would be?

S: Umm, ...from gross pay or net payment?

J: Err, let's see - on her gross pay

S: On her gross pay? It would be roughly about .... six pounds [5A]

J: Hmm hmm. Thank you. And could you tell me exactly how it would - much it would be?

S: Exactly? Umm..............[15 seconds]..No. [5B]

J: No?

S: I'd have to look it up again

J: You'd have to look it up? *uh huh*.............will it?

S: It wouldn't take me long to look up

J: Where would you look it up if er.............?

S: I have a maths text book on my shelf, and that's usually got most problems in there, examples, how to work things out

J: Right, oh, right. So, er is it one you've had for a while?

S: It's an O level book

J: *It's a sort of trusted*.....................

S: I've got the title of it if you want

J: Oh, yeah, that would be interesting

S: It's fairly comprehensive, um - "New Comprehensive Mathematics for O-level". You can read it in that

J: Oh, I see, right..uh huh............1979..........right, ok, thanks, so what would you do if you couldn't find it in - would you find this - something to help you with this in there?

S: Yes. Percentages, fractions, statistics (right) lots of things - very comprehensive

J: hmmm - good. But what would you do if there was a problem and you couldn't find it in there - what would you.......?

S: Umm........If I *really really* needed to know about it (uh huh) I'd ask around, I'd ask people (right) who could help me - after a while I'd probably find someone

J: Yea, yea, in a place like this.................. Right, does that remind you of any anything current or anything past?

S: It remind me of my wage slips from Medicare, Drugstore, fairly similar

J: The drugstore's called Medicare?

S: Medicare, yes.

J: Did you ever have to do calculations like this with your' Drugstore?

S: Umm. I didn't have to do - not wageslips, I didn't really look at them much I kept them stored away (right) sometimes say unemployment benefit they ask you for it (right) so I keep that stored away(right). I check to see that I've got the right amount so if they say one pound eighty eight an hour well I'll check it up according to the hours that I've worked to make sure that it comes to the right amount - to start with anyway, after that I don't bother.......(laughs)

J: Hmmm. Right, ok, anything else come up from that? er?

S: If I had um - therewas an unusual figure during one week - say it was a bit more or a bit less than that I usually ask I'd say what's this? how come it's not this? To start with I was taxed, not as a student for, well you don't get taxed after the first one thousand five hundred or one thousand eight hundred but I was being taxed to start with so I asked, um, I said I should be exempt from tax, and so they gave me a form to fill out (uh huh hmm hmm) and later on the figure went up because they payed me back and it was - instead of being fifty or sixty pounds it was seventy or eighty pounds and but that - I was getting that amount simply because I was being payed back from earlier on

J: Right. Right. And you asked them about why you were getting more or you were sort of expecting that?

S: Umm. I did ask them initially and then I realised why I was getting more because they'd actually been paying me back, but I didn't try and work out how they'd been taxing me,(laughs) I just trusted them (laughs)

J: Yes, some things are best... yes, mmmm, mmmm, but you had a basic idea what should be going on and you just (yes) yes mmm right ok, do you ever go shopping for food? [460]

S: Yes

J: Yeah, and where would you normally go shopping?

S: Errr....local supermarket.

J: Umm......would you buy tomato sauce or ketchup?

S: No

J: No

S: Sometimes, very occasionally

J: Very occasionally. Umm, if you were buying something else like say mustard or relish or jams, how would you decide which one to buy if you had a choice in your supermarket, say you decided you wanted English Mustard?

S: I wouldn't take mustard, wouldn't take jam 'cos we usually have homemade jam

J: Uh huh, nice

S: But if I was

J: What might you buy?

S: Probably look for the cheapest-either that or what I thought tasted best, usually the taste comes first, and then the money [the way I do it?]

J: Right...right......... right.......what kind of thing would you buy then? um in that area?

S: In that area? [6 sec] ..... probably Strawberry jam - that would be the only jam that I would buy

J: Right and so... ....?

S: But otherwise, I don't usually buy jams or mustard.

J: Right, so you'd go for that on the basis of...

S: My taste and then I'd think about price, if I saw a cheaper one.

[6] J: Right, ok, supposing you've got these two- these two bottles of - this is ketchup, I'm sorry, but er umm the larger bottle holds 30 ozs and costs 69p (hmm hmm) and the thinner bottle holds er 20 ozs and costs 52p, which one would you buy if you were buying tomatoe ketchup?

S: This hold 20ozs (that's right, yeah) - I'm not looking yeah 16 ounces, one pound (that's right) can't remember so that's 20 ozs and that is..........20......... 30ozs that's 30 ozs that's 20 ozs er.......... so er.......[12 secs]..................... I'd probably go for that one [points to larger] but I haven't worked it out(laughs).......[inaudible]

J: Hmm hmm So why would you go for that one?

S: Because it looks cheaper

J: What makes it look cheaper or?

S: Well, obviously, maybe it isn't but..............it's just the preconceived idea that you just presume that the bigger one is cheaper (mm mm) so you go for that(mm mm). It's not the sort of thing I'd work out (mm) unless I was - I'm not living on my own at the moment, if I was living on my own I'd probably work that out (uh huh) if I was short of cash (right) but as I don't normally buy the food I'd just probably buy that presuming it was cheaper (yes) I wouldn't bother working it out and spending the time (yes, right) I'd probably think in terms, well the time's more valuable to me that money at the moment (right)

[532] J: And how does living with other people affect that - you said if you were living alone you might work it out but

S: Oh if I was living alone, well, sometimes my parents go away so I have to buy my own shopping (right). It's not usually my money, it's usually theirs (laughs)

J: And you reckon they're not so concerned about it then

S: Well normally they would do the shopping but if they're away for one week at least they'll give me £10, if I need anything I go out and get it

J: Right

S: I don't spend too much time working out, I just get what I want(laughs)

J: Right.

J: Right

S: Except for if I was living on my own I'd have to work it out.....[no choice?]

J: Right. You could still do as you do now

S: Yes, depending on how much money I had

J: Ah, does this remind you of anything?

S: Just shopping

J: Just shopping. Yeah. Right, except that you don't normally make the choice on that kind of basis

S: Some - ya. Sometimes it's the sort of problem that does come up in mathematics in O level or CSE they present a similar sort of problem in that case I would spend time trying to work it out in the correct manner

J: Right, right

S: But at the moment I'd probably be pretty lazy (S. laughs)

J: Right, right ok thanks, well that's all the questions that I have to ask you. Is there anything you'd like to ask about any of the questions?(S: NO) Any of the ones we've done. Can I just ask you how you feel about the way you're able to use numbers generally at the moment?

[560] S: I'm quite happy

J: Err.........how could the course be arranged to help you with that problem, is there any way it could be arranged better to help you with that ?

S: For me? I find that I can't sit and just have a lecture on it I can't stand - I need individual attention to sit in and listen to a lecture, my mind will just wander off. It would have to be with a specific problem that I've got related to a subject (uh huh) or related to something else and then I'd make the effort to really work at it until I understood it (right) otherwise, no,

J: No? ok.

S: I'd just leave it

J: Are you getting enough individual attention, do you think. On the course as it stands now?

S: Umm, a reasonable amount, um, sometimes I mean I, I don't want to go to the seminars, I don't want to go to the lectures on maths, I just want to know that there's sometime during the week where I could perhaps spend an hour having a tutorial on it if I needed it (uh huh) so it was there just if I needed it (right) an hour per week of individual attention and perhaps I might come for three weeks in a row for a tutorial and the next few weeks I wouldn't come at all, depending on my need (right) to know it. And if its being related to a subject that I'm doing then I remember it a lot more (right) than if it's just on its own (uh huh).

J: What about, umm, a group tutorial, are you happy going with other people? Is that ok?

S: That's ok if it's answering your problem, your specific problem, but if it isn't answering your problem again, my mind just wanders off and I find it difficult to concentrate (mm) and if everyone had the same problem that would be fine, the tutorial would be good (mm) says on the worksheet sometimes, we've helped eachother on the worksheet, in the last group, not this term, but the terms before we've helped each other that was tremendous, that was really good cos you motivated eachother to get going and doing the maths (uh huh) and that was good, good motivation, for actually doing it

J: Uh huh, where did that happen? err

S: That would happen - we might go into the refectory and usually over coffee we would discuss how we're getting on with our worksheets uh huh) and someone would show, one person would have more knowledge on one aspect of the worksheet and they would tell us how to do it and I might have some knowledge that they hadn't got so we'd trade our knowledge on the maths (uh huh) and help each other to understand it (uh huh), and that was really good

J: Hmm, so that group worked well?

S: Yeah, it worked really well. I think the results showed it - that it did work well

J: That's right. Yes, it was a very nice group to be associated with and I think for all of us, but.... Hmm. Good, is there anything you'd like to say about the way the interview has been conducted?

S: Uh.. It's fine.

J: Was it what you expected or......... how do you feel

S: I wasn't sure what to expect. (uh huh) I was glad that it wasn't a yes or no answer(uh huh) because it's not sufficient,to just say yes or no to certain questions (hmm mm) So, yes, I was pleased with the interview (hmm hmm)

J: You didn't.. .... Did you find it nerve making ?

S: No, initially with the tape recorder there I ~~think~~ thought it did increase my nerves a little bit,(uh huh) just, yes it did, otherwise No......... [quietly]

J: Yeah, good, ok, well that's all I'd like to ask you, so um, thankyou for your time and um, and er turning you're mind to maths problems which weren't necessarily the one's you're thinking about at the moment, I appreciate, I mean I can understand that point very well, umm. the big question is - Could we teach methods and models that way, you know sort of responding to peoples problems

S: That's how I'd like it for a lot of subjects in fact (hmmm) that is how I work better, I know a lot of people prefer to have a lecture and sit down and take notes (yea) I believe in Sussex University they do that, just have tutorials, so they have about five tutorials a week. When I went to an interview there (hmm hmm) - and so people would come and discuss their problems, any subject it wasn't just maths

J: Oh, I see, right. S: I think for me that sort of thing would work. I'd need to come sometime I'd definitely need to come in a group with other people who were doing the same thing as me, cos that helps to motivate me (right) but otherwise just sit in a lecture, I just do not get a lot out of it. I prefer getting down and reading and I learn a lot more - and then discussing it

J: Right, uh huh, is that the same for other subjects

S: That's how it works for me its the same for other subjects to..............to a certain extent, um, like Research Methods in psychology where I have to be there for everyone really, otherwise I don't know the procedure of an experiment, I just had to be there to take things down. But where it's just a straight lecture (yes) then I would say, where Biol. Basis of behaviour, a lecture like that I could just as easily have gone home and read a paper on it, I'd have learnt a lot more than just listening, and taking notes, (right) and then I'd come back and ask anything that I didn't understand in what I was reading

J: Yes, right, good! Thanks very much S: When are you going to... ? (end)

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JE. Get us both some paper here S: I need a pen will I? J: Yes, if you would, ...

JE: Right. First may I ask you some questions about yourself?

S: Yeah, sure.

JE: What track of a degree are you on?

S: Planning.

JE: Planning. And was that the same as the one you came to do?

S: No I came to do social work .....

JE: And ... why did you change away from that? ..... Is that easy to answer?

S: Er, it's not easy to answer, um, the study of philosophy had some influence on it, but um I also feel any social work I do, I want to do it without being paid.

JE: Uh huh S:

JE. Right, you needn't go into it

JE: May I ask you how old you were when you joined the course, say 1st September.

S: 47

JE: 47 ..... Where did you study most recently before coming here?

S: Er, the W.E.A., Association

JE: Uh huh, and what was that er

S: Mostly literature

JE: What things especially

S: Er, the last couple of years it was American literature people like Faulkner, (mm) previous was Shakespeare and James Joyce (mmm).....

JE: How much did you use maths there if at all.

S: Not at all

JE: None at all

S: None at all

(029) JE: What level qualifications do you have in maths

S: Er, the Irish equivalent of 'O' levels or 'A' levels I'm not quite sure one or the other

JE: What's it called

S: Er, Leaving Certificate um Matriculation of National University.

JE: Uh huh. Is that a separate exam that you do only if you want to go to the National Univ....

S: It used to be yes back in those days, yes .....

JE: And that would let you go into any side of the National University?

S: It did state the subjects you had passed on, so I don't know if it would become - but they probably - if you went for an interview they'd make a decision whether the subjects you had would qualify you to go into a particular track I guess, it wouldn't take me to medicine

JE: Right, right. Mm thank you. Um what sort of work have you done most recently

S: I was a banker

JE: A banker. Where was that and what kind of things were you doing?

S: I worked mostly in the money market .....

JE: So you were in the City were you?

S: In the City yeah.

JE: Right. Right. Okay. I don't think I need that fact, I think I knew that from your other ....

And how much did you use numbers there if at all

S: All the time

JE: All the time, uh huh. Um, could you give some examples of what kind of things you ...

S: Er, well I used to buy and sell money and er I knew what percentages you need (J: uh huh)
You didn't have to think about it you just knew it (uh huh)
It wasn't like .... you didn't, as I say you didn't have to think about it you knew what the rates were (mmm) you just took a chance and said yes or no, (uh huh) and you were right six times out of ten

JE: Uh huh that was what you reckoned you needed to be right six times out of ten

S: Yeah, six times out of ten

JE: Yes. .... Is that six times out of ten is that a precise thing in any way, or is that just your feel for more than half?

S: No, most of us would like to think we were right 99 times out of a hundred, and I think we were but the boss said if you did six good deals out of ten you're okay (mm)...It is an ego job, I can remember every bad deal I've done (Really?) Every bad deal I've done (uh huh) Still remember them years later (uh huh)... Can't remember the thousands of

(060)

JE: Well you don't have to remember [S laughs] anything you do here [both laughs]
Uh huh, fine okay well um can we just try and see if this is working.

380

6.

[During this trial, he suggested the tape recorder would be less obtrusive, if I stood it inside one of my filing cabinet drawers, and on the table]

JE: Good. Okay. Well that's a relief isn't it to have that thing out of the way, and forget about it. Right okay
Well, I've tried several ways to let people get into talking about their experiences with numbers and the best way seems to be giving you some questions to try.

S: Fine

JE: Is that okay?

S: That's Okay.

JE: So I'd like to ask you if you'd mind taking a look at a few of these questions. Um for each question while you're looking at it I'd like to ask you to say three things which I'll remind you of so; first of all, what sorts of other things do you do these days it reminds you of if any? um secondly, I'd like you to, um, tell me as well as you can about how you're thinking about the question and what your answer will be, and finally I'll ask you what sorts of earlier experiences with numbers it reminds you of, and feelings it brings up

S: Okay

JE: Okay, now during the time that we're doing the questions I'll just note what you're saying but at the end if you want to we can take some time to discuss any of the questions that you wish

S: Right

JE: So, now here's some paper if you'd like some paper to ... you may not want that [7 sec.]
So here's the first question. Looking at this pie chart [1]
which do you think uses more water households or industry

with meters?......
[6 sec.]
S: Households [1]

JE: Households right thank you. Does that, with that one does it make you think of any other things you currently do?

S: I was just thinking if I should use a meter at home or not really, cos the water board do write and say do you want a meter at home (yes, yes) . . <that's all a list of things [quietly]>
I was looking at it there and I was trying to sus out (uh huh) the equalities that's all (yes)

JE: Right okay um er.. can you tell me about any sorts of earlier experiences with numbers that it reminds you of, or feelings it brings up?

S: No nothing comes straight to my mind at all

JE: Okay. Do you remember those from school at all or from work?

S: I find it very difficult to remember school at all (uh huh) (laughs) Not only just school but anything in my childhood really so um, it's .. I know I didn't ~~really~~ understand maths, thats all I know. I was good at getting forwards I'd get an answer to pass an exam (uh huh) but I'd no idea what it was all about. I couldn't tell you ~~the~~ any point in it (uh huh), couldn't see the point at all — to my real life you know (right)

JE: What were you mainly interested in in those days?

S: Literature

JE: Literature, uh huh ..... well can you remember what your favourites were in, say, early teens late teens that kind of time. Any particular ones stand out? [anything like that]

S: Oh Shakespeare, Bronte sisters and I ~~write~~ read alot of books. I ~~write~~ read escapism books (uh huh)

JE: Any particular favourites there?

S: I remember the first book I read was a book called Red ~~Plough~~ Cloud [?] about mid western America chasing buffaloes (uh huh uh huh)

JE: Thats pretty good memory

S: Yes I wanted to be out there with them, I'm sure

JE: Uh huh [5 secs] right okay thank you. Right now here's another one, does that kind of question remind you of anything that you do now [2]

S: Not so much now but at work I mean I get that kind of thing (uh huh) and I just move the decimal point to the left

JE: Uh huh so what would you get there?

S: .665 [3]

JE: .665 fine thank you.

S: I can read figures maybe more than understand them (uh huh) especially [when I was] obviously at work in my own business I could get a hold of papers, I could find the one that was wrong I just had a gift for that (uh huh) just a feeling for it, I did, couldn't tell you how I done it but I could do it

JE: Uh huh what did you mean by papers, is that ...?

S: You know you get a whole lot of figures and statistics and percentages and, ... you are expecting a specific result and you know it was wrong but I had a gift I could go through and I could find the one that was wrong because my mind seemed to often - you know I could run down the columns and computers and things like that (mm) I know what I'd be expecting and I, if something wasn't ~~could~~ ~~them~~ right, (mm hmm) I'd say there's something wrong, there ... Not always, but I had a feeling for it (hmm hmm) I had a feeling I just let my feelings go (mm) more than anything else really (mm)

JE: So what kinds of things that were wrong were you picking up in that context?

S: Er, someone had typed in or put into the computer a wrong percentage, or had put in seven months instead of seven days or something like that

JE: I see (hmm) That must have felt quite good to have

S: Oh ~~yes~~ very good, it did, it did, it did. Yeah, it took time to get it because I'd no confidence with figures when I started but ... sheer use made me good at them.

(147

JE: Was there anything else that would have helped as well as the sheer use in developing your confidence? ..... For example people you worked with or a training course they might have given, ~~you~~ or books that you might have read, or anything like that?

S: No, no, no I can't remember that at all. In business most people are very jealous of their expertise and sometimes they don't want to pass it on to you when its to their advantage. It's a strange you know and they're afraid sometimes that if they show somebody something they might do better than you are next week. So there's that kind of thing in business and it's a bit frightening. Er I think it's just a gift I don't know I don't understand it I can read figures like people read books (uh huh) (mmm)

(160/ms

JE: And when did that gift start? When did you first notice

S: I think it was two or three years after starting in the bank and I worked on the accounts (uh huh) section where er where we had to reconcile accounts and things like that we had a lot of money coming in and a lot of money going out, you know we had to make some kind of a (uh huh), juggle

them round balance one with the other, and see what the difference was and er I ~~thought~~ found I could just do it easy (mm) and I was amazed that I could do it that easy which was you know I didn't see any point when I was at school and I still don't see any point much in what I done at school, and what I done at the bank (uh huh)- ~~but~~ there, obviously once I knew the 1 2 3 4 5 6 7 8 9 10, I guess, but - I never remember looking back to school and saying that was an advantage (mm) but maybe it was I don't remember it (mm) at all

75) T...

JE: Can you remember, what you were, how you were thinking or what you were thinking when you went down these lists of columns and, and looked, looking in case there were any errors?

S: Looking for something different (ah hah) I was expecting (ah hah) something, here I am, it something I wasn't looking at the figures, I wasn't actually saying, [seven or 11 or ?] I was just letting my mind, run my finger down it or a pen helps go like that and if something's wrong, it will stand out to you (uh huh), sometimes not always, (uh huh) but a pen or a finger helps, (uh huh) it takes the eyes down with it

JE: Well thats er thats marvellous ..... good um now here's er number three [See ....] the graph shows how the price of gold varied in a day's trading, um does that remind you of anything that you do these days, or you've done recently? [3]

S: Er ~~school~~ some of the work we done in phase one, but if you ask me straight out of my head, what it reminds me of I worked once with a credit company and we had charts on the wall trying to galvanise each of us to do better than the other (uh huh) and these ~~sort of~~ Soddin' things were always there and we seemed to be slaves to the charts on which (uh huh) we sold, or whatever the particular thing we were doing at the time, (uh huh) they were used as a [3 sec.] .... and I found it impossible to ignore them (uh huh) even though you know that they're just getting you at it. They know that too

type

that's why they put them there you can, you're ego comes out and I must I must have a go at this (uh huh). That's what that reminds me of a bad feeling in a way (mmm) I felt that a human being was being judged by that bit of paper (hmm)

JE: Did you yourself have your own chart (oh yes) or was it a group chart?

S: No we well we had an office chart there but each assistant manager had his own chart, we had say, about 12 or 14 staff and they were selling and you wanted your crowd to be the best (uh huh)(mm)

JE: So it represented a team but it maybe had your name on it

S: Oh very much so yeah

JE: Yes I see .....

(217) S: So the feeling would not be good looking at that it would associate with (uh huh uh huh right) not so much that somebody would judge me but the fact I'd ~~be~~ wet bloody silly not to, to go along with it (uh huh uh huh) and I know I'd go along with it tomorrow again (uh huh) and that's even worse you know; put me in that situation tomorrow and I'd be a competitor just as much

type

222 JE: Uh huh you're sure about that, are you?

S: Thmhm, when I left ?aling er I went to an admin job

JE: ?aling was where these charts were?

S: No ?aling was on the market (JE: oh sorry dealing) yes dealing was on the market buying and selling money and you just you need a break you your brain is phases out and you get tired you want a break but I went to an admin job, and

(230) I found I was pushing on like mad, cos I had no excitement and then I settled down but one day the boss was away and they put me in charge and within five minutes I was full of

and ?] the

same as I'd been all my life so I switched back to to being competitive within five minutes (mm) that's why I don't intend to go back to that again, (uh huh) I'd still get the same I don't know it's just something in me that, I suppose in a bad way I feel too, because I don't care who you are if you put that on the wall behind you you'll judge yourself - I will, anyway. It takes a very strong personality not to judge yourself by that blasted chart (uh huh) everybody else if that's the criteria in the office (mm) it takes - there are people can do it, I think - I couldn't.....(10 secs)

247 210 JE: Right may I ask you which part of the - oh you mentioned something about phase one, does, (S. Yeah) does it [?]?

S: Yeah, well we done some of the questions like this and er the run over the ~~[?]~~ Pete and that kind of thing (yes).[5 sec.] .... trends, I suppose if you were judging a trend see how it was going, you could judge it over time obviously, that kind of thing which actually I find good, I like the fact I can do a chart now (uh huh) but even to do a chart like that now, I couldn't sit down and do it straight away, I'd still have to go back and think about it (uh huh) even you know a very basic one like that I couldn't rush into it like I could other things (uh huh), ... with maths I have to go back to the basic things all the time

JE: Mmm, why do you think that is that you couldn't rush into it?

S: I think its to do with my earlier experiences as a kid with maths (uh huh) I have an inferiority about it in some ways and I'm quite good at it (uh huh) that's the strange thing about it I'm good at it (yes) (yes, you are) I haven't actually brought into maths I haven't incorporated into me yet (uh huh) maybe that's the reason I don't know but I always have to go back to start, basics, and work it through (mm) as a matter er I was saying to [redacted], E.[his partner], I'd like, I'd like to do a degree in maths (mm) at the Open University, ~~you're misty~~ or something like that (great) so er R.

JE: They have nice courses there

S: They have yeah I've seen some of their books and they're really well done they're really good. But that's, I don't know, I couldn't tell you why I got to do that, but I just know I get a good feeling by doing it

(280 250

JE: Uh huh you get a good feeling if you do which?

S: I'd get a good feeling by doing a maths degree (uh huh, sure, I see) not an ego thing either, I'd feel fulfilled in some way but I don't know (yes). Maths and philosphy were my two favourite ~~fairly~~ good things, just like company work. (uh huh great)[10 sec]....and its hard to see a connection between the two but in my mind tells me there is (J: between?) between maths and philosophy

300

(mm)... my mind tells me there is a very strong connection

J: Yes well we teach them together don't we and try to make the link so I suspect that looking back at the figures that are talked about on both courses would show more the ~~where it~~ links, (really) you know you get a biography of Liebniz, or ~~figure like say~~ Russell of Newton (yeah) .....

JE: Right, okay, may I ask you which part of the graph shows where the price was rising fastest? [3]

S: If I was to make an instant decision I'd say that one but obviously want to make it on a count of the line wouldn't I (you'd?) I'd count a line (uh huh), as it goes up ..... 25 secs ..... eleven over ~~number~~ six and ten over six so that ones right in the first one [3]

JE: Uh huh the second one thats going eleven over six ..... 10 secs ..... Right thank you. Um and um what was the lowest price that day?

S: This one here five hundred and eighty [3]

JE: Right thank you. Um we talked (went high at the ~~er to~~ close, for some reason) pardon me?

S: Went high at the ~~er to~~ close

JE: Yes uh huh is that a surprising thing to happen?

S: No no at the last minute anything can happen (uh huh) because people are adjusting their positions for the day (uh huh) you don't want there's no point in having gold overnight, [cos there's no banks open?] you want to invest in something so (uh huh) you just want exactly enough of anything any commodity especially money (uh huh) that's the trick is to get exactly enough, not too

345 much or too little (uh huh) thats why the interest or night rates can go up from 1% to 50% in five or ten minutes. Thats the exciting bit of the day really (uh huh I see) you ~~dont have~~ be nothing to worry about ~~all~~ until the night rates you don't have to worry about long term (ha ha, I see) [inaudible ?]

JE: So that's the moment of the day when the decisions are in some ways clear.

S: Er, banks have to square the position with the Bank of England every night and er (mm) but the days when your intuition is good you can smell it you don't need-I don't know what it is-
350 on other days you can do it all wrong (uh huh) dreadfully wrong (uh huh) you can let it go at 5% and buy it at 30% ten minutes later (uh huh)—thats the way it is.

JE: Are those serious decisions?

S: There's a lot of money involved (uh huh) six or seven hundred million at a time you know

JE: Six, seven hundred million?

S: Yeah,

JE: At one moment?

S: Well, I used to do 250 million at a time you know, but (I see). It's not as complicated as it seems, there's only so much money on the market anyway (uh huh)

JE: That was the principal the interest would have amounted to only some thousands I suppose

S: That's right yeah (but still) that's why I say ~~when~~ once you're in there you do perform you wouldn't do a bad deal in a million years cos its yourself's on the line (uh huh) I think its a very sick business really (uh huh) it said more

about me than it did about the other thing really. I mean I feel more mature now that I don't need to (uh huh)
95 to prove that kind of thing to myself (uh huh). People die right left and centre from drink and drugs and everything

97 JE: Yes, yes. well did you ever feel, that sounds like pressure doesn't it (oh dreadful) did you feel the pressure or the anxiety? TYPE

S: Oh very much so yeah sometimes I got pain in your chest but I had to ~~level with it out~~ learn ways of not, of not bring it home with me (mm) but it was happening you had it, I mean you had the form gets stuck ~~into~~ into your hand, the tension, sweat (uh huh uh huh) But once you do a good deal, ~~it just~~ Somehow, it could kill you somehow,
98 you just feel good or something as if its your own money. But I found the people in many ways limited, uh huh) like lots of brilliant people in a very narrow field. They were brilliant at one thing, but they had no breadth - they couldn't talk about anything else (uh huh) the rates on the market or something like that. I've missed all my mates I used to have at the other place and we discussed politics and
100 things, (yes) I felt lost over there [in many ways?] I was good at it and I was honest, and that's [what ?] Cos you can [go bad?]

I felt lonely there, the whole time (mm). They're all kids all in their early twenties, twenty-five, twenty-six, [??? ?] and I ??? my father... But it does give you a grasp of figures, ~~well~~ very, you have to (yes), there and then, but its not mathematics I feel (I see) Its no help at all with mathematics, (oh) I didn't feel any help at all.

JE: Not even the diagnostics books?

S: No I don't think so, I was frightened of maths really (uh huh) it was the same as when I left school as a kid .....
That was if something in banking and figures were a job or something but maths were there to trip me up or something you know (I see [it was terrible?] uh huh uh huh). I changed as the time went on, that did change

JE: Which, the feeling that they were there to trip you up?

S: Oh no, I found a great and intellectual kind of a kick in solving things.

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JE: When was that, was that this year or was that earlier?

S: I'd say more, I'd say about the second, we started in September, say from December to Easter that (uh huh) term

JE: And what was it that happened then that you were mentioning...?

S: I found connections of something there to go from one thing to another and I ~~thought~~ found it exciting (uh huh) you know I couldn't get bored with it at all.

JE: Mm, you certainly seemed well into it um almost all the time yes.

S: Oh I did I did I liked it. But as I said (J. good, good) when I started my work [I couldn't do anything ~~had put~~ them together but] I couldn't connect the two at all (uh huh). Well it ~~induced~~ gives me, I feel, not to be afraid of figures but the formulas and things still ~~before that I think I was too~~ frighten me really (uh huh). I could feel my mind [oh, yes?]

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JE: So is there some division between figures and that's something to do with work, and formulas had something to do with maths and school would that, does that capture what you say?

460 S:...I don't know ..... see at work I think I played on the fact that I had a good brain for that thing it made me feel good I suppose.

JE: Yes, sure, well that seems very reasonable.

S: [laughs] Yes it does yes.... And I thought now that I know I can be good at this too, I feel better in that sense, [the way it is?] And I can make connections and I don't have to

(End of side 1 of tape.)

(Side 2:-)

JE: and also about feeling good about wanting to do well at work in a different job

~~JE~~: I can understand that (S: uh hum)

S: [laughs] I think that there is a difficulty in maths when you're doing different subjects and disciplines and things
But I think thats not confined to maths, I mean I've spread myself midway now, at the moment, I do two planning subjects maths, philosophy, political economy and political philosophy but I find it sometimes a bit difficult to jump my mind from one discipline to another. (JE: uh hum) I was warned about that when I started but that was the choice I took, cos I wanted to do that. I could also see connections but I could also see it would be easier if you stayed in philosophy, or maths, or... It would be easier but maybe not so er rewarding, because I think everything is connected, y'know, especially the [ ], if you're a [?]
But its harder to make connections than it is just to stay in one discipline (yes)

JE: Uh hu, uh hum, ~~Yes~~ I agree with that

492 S: As time goes on it will get better I mean I see lots of

connections between the political philosophy and the political economy the core theme especially (yes) and I think about that (yes) lots of things, and I think the statistics would come into that the next time as well (mm) and the planning (mm) that's-its all together really. It's not that easy in your mind to keep them there and to sit down and study them in separation, that's a difficulty sometimes-cos you sometimes forget one of them altogether and so often you're all doing the other ones, it's like ....

I mean I found this maths work sheet we're doing now difficult-and its easy when I sit down and ~~and I said I'll~~ think about-its easy but the block was there (uh huh)

JE: And what did that block feel like?

S: Panic

JE: Panic, uh huh. So when you look at a question what happens? Could you maybe describe what happened when you looked at one of those questions?

S: Some kind of inferiority inside of me says I can't do it. (uh huh) My brains tell me I can do it, but something says I can't. (uh huh and we?... sorry) I got about three or four books out of the library on the first question I knew that question, I knew it was easy. I know its easy now but I've done it. But I got four or five maths books out of the library. I found some of the maths books I don't know badly written or something (mm) (you still looked at them) I find that the best books I found that they were the Open University ones but they haven't got

ones on this particular thing they're doing now I think. I found them logical. They give you a question not an answer then on to the next bit. But some of them bloody maths books-I don't know who or what they were written for-but I don't know whether they assume too much or what but I haven't found them easy to follow or to read at all. (mm) For people like me, the Open University attitude is the best one (uh huh) and you can go back on yourself and things like that where some of them other ones are, they named expensive books (hmm hmm) I had four or five of them at home, but I still couldn't come to terms with it but its difficult questions like that on the maths sheet ..

And I'm sure thats not cos I'm stupid, it certainly isn't but er I ~~think~~ find I'd have difficulty ..... that's if they went out of their way-they didn't go out of their way to make it complicated-but they didn't go out of their way to make it simple, either.

JE: Uh huh. What presentations, either lectures or books, or seminar discussions, have you found help make it simple this year; can you mention any?

S: Oh yes the discussions in seminar. I learn better in group situations (uh huh) – thats where my mind is. A lot of peoples ideas flying around

JE: Yes, and that was a good group for that

S: Oh very good indeed, very good indeed er..... yes, yes I er the lectures, now I don't know if I got much from the lectures at all (uh huh)-maybe I did but er looking back the [illegible] of things where I got breakthroughs was in

410

the seminars.

JE: Hmm, mm, I think its good to go for more what helps you.

S: Yes, yes, yes.

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JE: Right, okay, um do you ever go to a restaurant with a menu [4] anything like this?

S: Yes, well I'm a vegetarian so I (uh huh) I go to a restaurant, but usually not that type of thing, but you usually have a couple of hot dishes, and bits and pieces

JE: Supposing with that one you asked the waiter and he said we could do a three bean salad for £3.53 (yeah) um would er would you then feel you could choose a dish from that menu?

S: Oh no doubt, yeah, no doubt. But I mean I wouldn't pay that much for a start (uh huh uh huh) but I would be certainly, there would be no problem at all. Why are you expecting I should have a difficulty in that?

JE: No, no - a difficulty, in what way?

S: I mean I don't see any difficulty at all in choosing the food.

JE: No, no. I'm just asking you to choose one, and I'm aware that as you're a vegetarian.

S: Oh yes, sea food platter, yes.

JE: Yeah, but would you eat sea food platter? You'd rather have a salad wouldn't you?

S: I would of course, well I'd give a bit of old nonsense really, do a bit of grovelling, and ask for a jacket potato see with cheese or something (oh okay)

500

JE: Okay, and supposing he said that'll be um er let's see

supposing he said that'll be um er £1.13.

Now supposing the amount of service that's left is er up to the customer what would you do in that situation? about service?

S: About giving him a tip you mean?

JE: Yeah.

S: I wouldn't give him any tip at all.

JE: No, right, okay. Um could you tell me what, um supposing the service were 10% could you tell me how much that would be on £1.15?

S: £1.15, [illegible] 11 [uh huh [quietly]] 12p, 11 pence, or 12 pence.

JE: Yes, thank you. Um does this remind you of any early experiences with numbers?

S: No. No, no. .....

JE: Right, okay. Good, well er that's all the questions I have to ask you cos we're running out of time, it's coming up to 7 minutes to 11, and so I just wonder if there's anything you'd like to ask, about any of the questions.

S: ..... I don't think so..... I mean was there a point I'm not quite - what would be the point of asking ~~back~~ that just to see if I - it wasn't to see if I knew 10% of 6.65?

JE: Well, it was really the three things I mentioned, does it remind you of anything you do these days (oh yes, yes) er how would you think about it, and does it remind you of any earlier experiences (yes, yes). These are just different questions, to um give you a way in to talking about your experiences (yes, yes) .....

S: I mean things like that in the shop were things that my mind would just make prices up er I wouldn't have to think about it at all (uh huh). I'd just make them up.

JE: Uh huh, how do you mean you'd make up prices?

S: If, say, [had] some [where ?] , say, reduced by 15%, I could do it in my head without thinking almost. Actual figures like that don't faze me at all, its the - the things which would faze me would be the formulas.

JE: Uh huh, yes. S: and the rules

S: I think its because as a kid, the things were splashed up on the board and nobody said what the hell the reason, or if they did say what the reason behind it were, I wasn't listening, and I couldn't relate it to my life at that particular time. ~~You know~~ I remember, things like pie and all that kind of thing, I remember with great [regret?] that's all gone for me - I don't know about the rest of them - which was a damn shame, but thats the way it was when I went to school anyway.

JE: I think a number of people have that experience.

S: I dunno... But it does leave a mark, I think, that the formula is more frightening than the actual work, in some ways... And the only way I might get to overcome it is to do it.... [the other way, that's normal?]

JE: Why is the formula frightening? I can understand its being boring, but um what makes it frightening?

S: [Sigh]. Because I think its divorced from reality in my mind. The things I know I'm good at and I can do like columns of figures they're real to me (uh huh), but the formulas seem to have nothing to do with those things at all (uh huh) and I know it has all to do with it because but if the formula's given first you just work from it - now, I don't see any point in it (yes) and of course I feel if it comes up

again, I don't know what I'm talking about. I get an answer or something, if I stare at the formula, but till I get into my head what it means I'm not happy (uh huh) out I think maybe thats because I'm made like that anyhow with any subject I'm doing I want to get behind what the, uh, reality is ...

JE: I think many people feel that, and I think its a good thing to feel I don't think there's anything the matter with it at all. It's a kind of integrity.

S: Yes, yes, that's it. I've seen people, they do copy their maths. I couldn't do that. I could do it but I wouldn't get any kick out of it. (mm) Yes I'd go and ask people and discuss with them, that's different, and work it out then, after. but as far as copying down I might discuss with people I thought were quite bright, on A-levels and all the rest of it in maths. I asked one guy about can't remember what it was now - yellow ... er (book) etc) diagnostic he said do this that and the other I said why. He'd no idea (uh huh) he's got a level maths (I see) but I'm not happy with that. [J laughs]

JE: He said I'm not happy with it are you?

S: I said I'm not happy with it, you know, I want to find out more and I did-I mean, I can't remember what it was but I eventually got to know more what was going on. But he was happy enough to accept (mm) that he could do it. That's fair enough its his way of doing it - I suppose I'm not under pressure. Well, I'm happy, I'm not under pressure to succeed like maybe the young people are but I'd still like to get a good degree (sure,

sure) but I'd like to enjoy myself more you know ... I came with the idea that I'd study to enjoy myself but I find that I'm competitive even here.

JE: How does that work, I mean?...

S: I mean I put in for philosophy I said I think I got an A- and I thought that's good till I saw someone had an A+ (hmm A+ hmm) I know I was better ~~for~~ than him I thought I was better ~~for~~ than him but um I don't know I've tried to lose it but ~~I don't know~~ it's very difficult. You know I want to get the position that if I'm good enough I mean that's good enough but er I haven't got there yet.

JE: Hmm, ~~well as long as~~ it sounds as if you're clear about where you want to go.

S: Oh yes, very much so, very much so, yes.

JE: Right, well I'd like you to keep - oh I do want to ask you how you feel about the way you're able to use numbers at the moment. [interruption] How do you feel about the way you can use -

S: Good about numbers, good about numbers. I still haven't ... my initial thing with formulas and things like that is a bit of panic (uh huh yes). That's really I think why I want to do the maths degree (uh huh) in the Open University. But I have a mate who's done a Science Degree there and he was really turned down by doing it -

JE: He was really?

S: He was turned down by doing it in a way and (TRODDEN DOWN) Ohe he was really trodden down. He really done a lot of good to do it he felt great about it but no he's started to do a social science degree so (uh huh) I wonder if I'm going to do it the other way around.

JE: Wonderful, good, good.

S: Um I feel in political terms and things, it would give me advantages. People trot out all kinds of bloody things and I do myself-and sometimes I couldn't substantiate them - they can't substantiate them either and I'd like to be in a position to say: look here, this is the way it is and to be able to prove it if I have to (yes) I wouldlike that ... I know it can be done ... without being too er you know, going to um ordinary figures and just say this is the way it is, from my point of view anyway.

JE: Good, is there anything you'd like to say about the way the interview, um, was conducted?

S: Well I've never had an interview like this before (mm sure) Because if you'd told me exactly what you were looking for or something beforehand I might have some idea but no

JE: That was fine what you said and I was wanting to give you a chance to talk about your experiences. Could I ask you one thing and that is not to tell anyone else who's coming to the interview exactly what goes on so they don't have any special expectations? (S: I'll make sure) May I ask for your permission to quote things you said here in a suitably anonymoused form of course? (S: That's fine) things I may write later.

S: No problem, yeah.

JE: Thank you. Well I have had the transcript of this interview typed up which you'll appreciate may take some time. I'll offer you both a copy of that if you'd like and a chance to talk to me further about things that have come up if you want to. That'll be well into next term. (yes.)

JE: Okay, well thank you very much. I very much enjoyed that and it was nice for me to start with an old friend so (okay) good, good.

S: Go do some work, I guess.

JE... INTERVIEW 86/10

JE: Okey, so first of allmay I ask you some questions about yourself.

S: Yeah.

JE: Okey, you mentioned that you're on the economics track, is that the same track that you came to do?

S: Yes [. ?]application form

JE: Right, okey, and how old were you when you joined the course last September?

S: 20

JE: 20, right, thank you. And where did you study most recently.

S: A technical college in ___

JE: In Essex?

S: No that's East Kent

JE: East Kent, right.

S: Near Ramsgate.

JE: Near Ramsgate, right. Maybe I was thinking of Thaxted
(Yeah) perhaps
and what did you study there.

S: A three A-level course in Law, Economics and History.

JE: Uh huh, right and how did you find that

S: Well, I found it very interesting because when I took my O-levels I concentrated on science subjects because I was thinking, you know, science would be more useful to me and taking three A-levels in law and social sciences I found interesting (uh huh) but before it was really very numerical. the subjects I was taking

JE: Like what?

S: Physics, electronics.

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JE: Is this an O-level in electronics?

S: Yes.

JE: I see.

S: And I took maths, plus I also took geology which I thought wouldn't be mathematical but I ended up having to work out slopes and dips and strikes.

JE: Uh huh, what are strikes?

S: Well, a strike is where one rock meets another in the seam and the angle of the strike is calculated using tangents (I see, uh huh) and its useful. columns (right)
and also .. [seems?] (where you?)
when you look at landscape and see where two different types of rocks meet, by the way the different types of rocks have been eroded, you know, one rock is harder than the other and so the one that's softer is eroded faster you know (uh huh) and you can see the angle of the harder rock into the ground shows where it dips underneath the surface (uh huh) its something I did a long time ago, so I'm not awfully clear on it.

JE: Well its just interesting to know where you use these things sometimes. So, Good, right, so you've told me about your O-levels and the A-levels um what um qualifications do you have in maths do you have any?

S: No I've just got well I have a CSE 3 and O level Grade C which took me three attempts at O-level to get (uh huh) I found it-I don't think I found it particularly difficult-it was just getting the extra marks because I got two Ds and then a C.

JE: I see and you need to have a C to pass do you? (mmm) So I guess you were pretty pleased when you got it eh?

S: Well eventually, yes, I mean by the time I'd taken in three times I thought it was, not easy, but I thought how on earth could I fail? something that was just annoying and also the grammar school where I was told me that um you know you need an O-level maths to stand a chance of getting onto a degree course, y'know, [along with the English (?)] and it was just one of those things that you were told was essential so I had to keep taking it until I passed it. So I was, also, - I was under a little bit of pressure

JE: Because of what he told you. (yes) Were you at that time thinking of, what were you thinking of doing, were you thinking of making this change to social science was that already in your mind when you - ?

S: No, no, y'see I was influenced by ~~one of~~ my brothers and my

48 father - see, my father's an engineer and all my brothers, bar one, ~~of my~~ one teachers (and I was not pushed but I was um gently persuaded in the area of taking sciences at O-level then another two sciences at least at A-level (right) going on and doing some kind of teacher training degree like, probably with something like physics in mind, hoping for an easy job at the end, - not an easy job, but an ~~and~~ easily attained job (right) so you know I was always pushed towards taking maths at O-level and A-level and also physics at O-level and A-level (hmm), and unfortunately I just didn't master ~~know how to do~~ either of them. So its really - because I failed physics twice at O-level as well - so I think that meant that if I was going to take A-level I would have to look elsewhere (uh huh) thats where social

60 sciences came in.

JE: Right, what do your brothers teach?

S: My eldest brother is um a computer studies teacher and he's actually got, sort of, um a Bachelor of Science in physics and he teaches O-level and CSE maths, O-level and CSE computer studies and physics, and my second eldest brother he's a history teacher (right) and he took the arts. And the next one down is a craft and design technology teacher - he took physics and geography, I think at A-level. And then the next one down is a town planner (uh huh) and he took physics, maths and geography

71 at A-level and as I said my dad's an engineer and um he's very good at maths ~~that~~ which is a shame really because he's always tried to teach me and I've just couldn't ever have ~~hasn't~~ much success.

JE: Hmm, can you say a bit more about that I mean what happened when he tried to teach you?

75 S: Er I see to get me through my O-levels both he and my oldest brother almost constantly you know tutored me in my homework and everything, and my dad is the sort of person who will if you ask him a question instead of giving you straight answers he says well hold on a minute I'll go and find a book - and there's another book and then another book and hopefully a five minute explanation turns into half hour looking through Maths Made Simple or you know The Modern Algebra or something like that you know and you're getting a very complicated explanation. And I found from that that I don't think I was ever really interested in mathematics, you know. Its something that if I knew it, it didn't really make me feel on top of the world, you know (hmm) whereas some of the other subjects I learned - a bit of economics or knowing a bit of law comes in more useful (hmm) y'know its just ~~how~~ you channel your

87 life I suppose.

JE: Why do you think your father wanted to get a book when you asked him a question was it that he didn't know the answer or... ?

S: No, you see he, he um never, he um instead of taking O-levels, A-levels, degree he because of his age and because of the time he was doing it-he took scholarships and then certificates and then diplomas, and then, you know, higher diplomas and (oh yes) and he never really ended his education until he was about fifty-54 actually-because he had to, in the job he was in, he had to keep abreast of all the new ideas. (uh huh) He's-er was-an engineer with the C.E.G.B., so he had to keep a good knowledge going-and I suppose mathematics is used in his job (uh huh) and its also the way he is I mean-he just likes to explain things very methodically and making sure he gets everything right before he tells you something (uh huh) instead of jumping in the deep end... But and its the same with my brother unfortunately, but my brother being a qualified teacher as well, made it even worse you know: if I didn't get anything right then it was, it was even more you know

104 lecturing and er you know sort of not exactly-saying that I was stupid, but getting [only] ... [bit ?] so I suppose I became a bit scared of maths in general as a subject as well as physics (uh huh) and as I say, it was a relief to take something else as, as non-numerical or as easy to grasp as Law or Economics or History ~~before everything was a mystery~~ (right, yes) - there are numbers involved, but they're just not forced on you in the same way, not quite as [quickly (?)] and I never really found mathematics in economics hard to handle (right), [... not that much ...] just the last term, because they're letters you know instead of using a, b or x,

116 y you've actually got a letter which you know what it represents I for income and T for taxation.

JE: (interruption) Excuse me for a moment [15-20 sec]

JE: Sorry about the interruption (S: Alright) So you were saying that the letters are easier to understand in economics because they -

S: They represent something I actually understand (right, right) and I suppose it doesn't really matter how complicated the mathematics gets as long as I know what the numbers represent. It's one of the things that always ~~I found it~~ baffled me about algebra; it doesn't matter how quick it is to write it down on a piece of paper, there's ~~with~~ no excuse to make ~~look~~ up the symbols to replace something ~~when basically~~ with an actual, y'know, reality?

17 JE: So thats something that you -

S: Its very easy to get confused, you know, I mean-in a lecture if your concentration goes for a minute and you come back from a daze and you just don't know what on earth's going on, and all of a sudden there's an a that's replaced (yes) with something tangible like 'James' age' of 13 or you know a "b" or "y" or something like that you know. Its even worse when through absence you've missed a lecture on mathematics and I'm talking about the present course and you come back and find a symbol like sigma which actually represents something incredibly simple but because you weren't there you don't have the faintest idea and you feel as if you know you don't want to ask you think that someone thinks you're stupid and When you do ask and find out what it is and it makes you wonder what it's all about, what it's all for. As long as you can look in a book, if the date of a battle or a statute or something

JE: Did that happen to you much where you'd been away for a

143 short time and you'd come back and found [?] unknown symbols

S: Well its like the last maths work sheet for some reason I missed the lecture where question 9 was explained so I

never-I completely missed the lecture on ~~pie~~ chi-squared.
– Someone told me basically how to do it and I was completely mystified because I didn't know, didn't know the actual, the background you know (uh huh) and thats another thing I think I need to know everything about a maths problem, everything about a maths, an idea in maths, for me to understand it. (right) I can't just have the formula written down in front of me. I think I need to know a bit more than that

JL: Like what sort of thing would ~~pie~~ chi-squared, would you want to know more than just the formula

S: Yes.

JE: Can you say the kind of things that you might like to know, in addition?

S: Well as far as I can see ~~pie~~ χ^2 squared to me–because I mean I've only just learnt how it works – (sure) is a way of assessing data, but there's no more. But it can't be anything like that: ~~because~~ its a mathematical idea isn't it and it's nothing to do with data it's to do with um well I suppose a formula of some kind.

159 JE: Uh huh and so you need some help in understanding how that mathematical thing could have anything to do with (yes) empirical data?

S: Yes. That's the good thing about this course as far as I was concerned because I hadn't done any serious maths for about 2 years because of my A-levels (right) and I came here and everything was explained very thoroughly. (uh huh good) And Very simply and its the same, see I'm taking the mathematics option on the economics track (right) and A.'s a very good teacher - she explains things very simply and it's a bit boring for some of the people who've done A-level maths but for me-it makes it easier for me to understand. (Great) And I think hopefully

I'll be able to master ~~that~~, the approach, to estimation of ~~you know~~ that particular type of mathematics she covers. But some of the other maths I still don't get, it still hasn't stuck in my mind. I also missed the lecture on calculating correlations and I ~~never had~~ knew how to do it for maths sheet 3 and I'd completely forgotten how to do it for maths sheet 4 it was something that hadn't stuck in my mind because I wasn't there for the lecture I wasn't there (yes) from the beginning (uh huh).

JE: So what do you do in a case like that when you need to do it for Worksheet 4?

S: Well its like work sheet 3 I and the take home paper, because I'd missed the actual explanation of correlations, I tried to get a few friends to explain it to me–which didn't actually work–and then I went up to the library and got three or four

180 text books and a couple of them were completely mystifying and fortunately, one of them, one of them, explained it quite well, and it was an American textbook. And from that going through it step by step I was able to work it out for Worksheet 3 (good) and, unfortunately, it ~~stuck~~ hasn't stuck in my mind (Umm).

JE: But why would that be, do you think, that it hadn't stuck in your mind?

S: I'm not sure–I think it's either something to do with the fact that I missed the lecture or it's to do with the fact that er its been said that in the statistics section of the economics track next year that correlations and regressions would come up a lot so I've been saying: well that's alright, I'll learn it next year yo know I'll be able to get full grasp of it next year and it'll be taught to me properly - it'll be taught to me fully again, because I missed it the first time round it's not something that's stuck.

JE: Uh huh, so in a way you've sort of put it off (Yeah) saying you know I'll be able to do that at a later time (yes). Uh huh... (Yes).

OK. Could I ask you if you've done any paid work any temporary jobs or part-time jobs?

200 S: I've done a bit of stock-taking and I've also worked for a camera firm, I worked for a camera firm last year at the Open Golf Championship.

JE: Uh huh. What did you do?

S: I was mainly showing people how to use the cameras. (uh huh) Explaining the technicalities of the camera - it was Nikon cameras, and as well as showing them how to use them so they could actually go and take photographs of the golfers ~~tournament~~ I was also trying to sell the things as well you know so you had to try to tell them how sophisticated they were and how much better they were than any other camera in the world - even if they weren't (right), so er —

JE: So what? people could rent them, (Yeah) or borrow them?

S: Yes there was also a till there, So we had to take money... and load the cameras, service the cameras, and then take the security numbers and hire them out. (Umm) And that's about the only work I've done. This summer [I'll be going to pay off the overdraft]

JE: Uh huh do you have any plans for what you're going to do then?

214 S: Er no I live in a seaside town. So [It shouldn't be difficult, I don't think]

JE: Mmm which one's that

S: I live in Margate.

JE: In Margate, right.

S: There's a lot of work on the side ...

JE: Did you use numbers very much, if at all, in the jobs you mentioned stock-taking or the camera work?

S: Well in the camera work as I say the only real numbers that you had to use was um looking quickly at a security tab and remembering the number to be able to write it down, y'know. Stock-taking - it was only like a hardware warehouse, it was just counting screws and file handles and things like that. It wasn't [very mathematical at all] - apart from multiplication, if you had a hundred boxes of fifty screws [... ?]

JE: Right. I've tried a number of ways to help people get into talking about their experiences with numbers and the one that seems to work the best is if I give you a few questions to try ~~and Are~~ Would you be happy about that?

S: Well, reasonably.

JE: Reasonably.

S: Yes, I've been to a couple of job interviews where there's been some pathetically easy sums on a piece of paper but ~~because of~~ because of them, I haven't been able to do it. (Uh huh) I'll have a go at them anyway [quickly].

JE: What - you found them easy but you also found them hard to do?

S: No. I know they've been easy because they've been addition, multiplication, and division, you know that sort of thing but because they've been on a sheet set out in front of me with someone looking over me (yes) I haven't been able to do them. (yes). I think that's something that's come from having been taught by my father [in that way?]. Yeah. So.

JE: Yes, I guess you've always had a lot of people looking at (S Yeah) you when you've been doing maths I mean in that family with all those brothers, (S yeah) older brothers, yes... Well I hope you wont find these difficult and I hope uh [1sec] my being here wont put you off. [No resp] It's Basically its a way of giving you yuh c. ance to talk about your experiences with numbers and its not a test, OK (S OK) For each of the for each question while you're looking at it I'll ask you to say first of all what sorts of other things you do these days that it reminds you of if any. Secondly I'll ask you to say a bit about how you're thinking about it and what answer you would give (uh huh) and finally I'll ask you what sorts of earlier experiences it reminds you of. (okay, right) During the time that we're doing the questions I'll just listen to what you're saying but at the end if you want to we can take some time to look at any of the questions that you'd like to (OK) Ok? Right here's number one. How does that remind you of any other things that you currently do? [1]

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S: Well no the only thing that really springs to mind is computer because I've just done spreadsheets and using data on computers.

JE: Oh yes, I see.

S: Uh [5 sec.] I would say households use more water [1]

JE: Fine.

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S: Hold on [2 sec] No the industry because of the unmetered and the metered (JE: Uh huh) [S: (?) Didn't see that (?)]

JE: ~~Uh huh,~~ Let's see... right okay now it says looking at this pie chart which uses more water households or industry with meters—

S: Oh with meters, well then households - its households.

JE: Okay, and does that remind you of any earlier experiences 295

S: Well I did pie charts at primary school, ~~and~~ right through secondary school, up - well, you do them in CSE, ~~and~~ I can't remember actually having them in O-level.

JE: Uh huh, right, and does that bring back any memories for you?

S: Yeah, I suppose in - ~~Well~~ I suppose primary school and early secondary school maths classes. I think statistics on pie charts represents a ~~the~~ moment of relief in a maths lesson you know - oh, that's easy, I can take it - I can calm down for a minute .. umm

JE: Whereas the rest of the time was more like what?

S: Well particularly if it was algebra or um [3 sec.] I seem to remember in my first year at secondary school having long multiplication questions and not being able to do them, being scared out of my head at being marked and have todo long multiplication problems (umm) think it through and then I remember in the fourth year I was doing CSE falling asleep in maths lessons and being caught day-dreaming you know and "what's the answer to this question?- you" and then I would have to wake up and admit to the fact that I wasn't paying any attention to them

JE: Uh huh and what happened then?

S: Well usually he was the kind of teacher that would say this is very very naughty-never mind we'll let you off (uh huh) you'd feel a bit embarrassed for about quarter of an hour, very hot under the collar. I think that was something that was unique to maths lessons, y'know

JE: What was that?

S: Being asked questions and not knowing the answer and being able to being very very er-first of all you know embarrassed and ashamed and then a little bit angry at being asked a question in the first place. What am I doing here you know, sitting in front of these useless numbers - they'll never be any use to me - and why would I want to know how long the side of a triangle is you know (uh huh)

JE: So those are feelings you can remember having in say fourth year ~~yeah~~ yeah?

S: Yeah, or all through secondary school in maths classes you know, and Er in maths classes you're just either very boring or they required a lot of concentration to keep up (uh huh) as far as I can remember (yeah) you know and um and also what I remember about the maths class in particular was the fact that the teacher trying to explain something to you on the board and you felt that you had to write it down so while you were writing it down you missed the explanation (uh huh) Still happens now.

JE: That must have been frustrating.

S: Well it's very frustrating because you want to listen and you want to take it all in, but yet you know you've got to write it down so you can do exercises at home. It's like [a lecturer] scribbles away on the projector and then says well you do this such and such an exercise, and if you haven't written down the basic rules by the time you get home you've forgotten or its not clear in your mind so you need the basic rules to remind you how to do it properly, So you've got to write it down but you've also got to listen to her to try and understand and sometimes she goes [pretty terribly] fast.

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JE: Sounds like quite a dilemma actually.

S: Well it only happens occasionally, so That's something I've always, y'know - since the first time I took O-level maths, I started really.. we had a teacher who would write on the board and explain at the same time. She would be writing and talking at the same time and we'd be having to write and listen at the same time and its just not very easy (mm) You can't take it all in. you just either put your hand up and say look I don't understand this you're doing it too quick - What, y'know, not very many kids would say —

or you just sit there and think I'll just have to try and figure it out later as long as I can get the basic rules down I'll have to look at it later which you never do and you get further and further behind. (um) Something unique to maths class, I think - well, not so much physics classes because the examples are so more so much more useful [Dm] calculating the force of (?), of a falling block of wood off the top of a roof or the voltage in a circuit (right)-seems to me its far more practical. I think I found the practical things in the er whatever the other subjects you know I like to see them in black and white

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or in you know blocks of wood (yes) and I don't like working with theories very much [3 sec]. I suppose thats why economics seems a bit very clear to me because the theories relate to actual government policy (yes) or er actual market situations.

[6 sec]
JE: Right thank you. Here's number two. Does that remind you of any other things you do currently these days? [2]

S: Er, at the moment yeah, working out interest (uh huh) in either own accounts I've got in Building Society or with Kathryn cos we've done compound interest and simple interest quite a lot recently.

JE: Uh huh, so you have your own accounts in Building Societies (yes) that you do this for?

S: Yes. Well recently yes. (hmm) Money from the [Trust ??] I've been trying to figure out the interest I could get (yes, uh huh) Trying to figure this one out I suppose I'd say 10% of 665 would be 66.5 and then divide by 10 I suppose, either that or it would be .6 for every, no it would be -

(JE: would you like to use a pencil?) It would be.

S: No, No, I'd prefer to try and work it, well it would be one one in every ten so that's um [three] no it would be far easier to say 665 so 66.5 what would be .665, yeah

JE: .665 thank you. And could you say a bit about how you were thinking about that? You started off with er -

S: well things like that I try and make it as simple as possible (right) and try and get to somewhere something which I actually know (uh huh) so-if I was right that is-um 10% of 100 would be 10 (uh huh). 10% of 600 would be 60 and 10% of 665 would be 66.5 and then it would be trying to get it back through decimal points which I didn't figure out at the time, so because I couldn't figure it out I tried to do it the other way er which would be er 10% of one ~~which was~~ would be .1 so 10% of 6 would be .6, 10% of 6.65 would be .665.

JE: Fine thank you.

S: And I try and do it from either end (right), to make it as easy as I can, without just doing the problem straight off. (right) Cos usually I can't do it straight off.

JE: Um? Fine. Does it remind you of any earlier experiences that one?

S: We do percentages a lot at secondary school, or I did. It's one of the things I was able to do and you can work it out

394 on a piece of paper if you want or you can work it out in your head. I prefer to work things out in my head then write them on pieces of paper (uh huh) particularly with maths.

JE: [3 sec] Why is that?

S: I don't know, maybe people can't see what you, what's going on in your head and they can see what you're writing on a piece of paper.

JE: I see, yeah, right.

S: And also you know I haven't exactly got the quickest of

403 brains for maths. So if I've got something in front of me which I don't quite understand, then I've got to just sit and just think about it for a couple of seconds I suppose as it were] I . . . [odd like that?] But I don't reach for a book.

JE: Hmm, it's quite impressive to see people doing things in their heads. (S: umm) Because I think at school often you are encouraged to do it with pen and paper, there.

S: Yeah, oh yes you are encouraged to put it all down on paper and sometimes when you when I've done er you know - not ~~just~~ maths worksheets - but when you write out your answer to a maths problem, I find it difficult to write out all my explanation because some of it's been in my head and I haven't, haven't remembered to write it down. (hmm.) I think - You know sorts of things I do in my head like percentages or multiplication, division, that sort of thing I can't think anything more complicated, I can't think of anything more complicated, but.. All,

424 some of my friends have worked behind bars and I've always thought well how would I cope working behind a bar you know when you have to add up a round and I'm always sort of left doing it in my head and I do a whole-what I would say whole numbers first you know and 65p plus 50p plus 20p, then I would do sort of 60p plus 50p plus 20p plus 5 instead of ~~and just~~ adding it, um together. (right) ~~takes it~~ that's easy ~~way to do~~ if it's a more awkward number like 68 or 64, or something

434 JE: Right, fine, thank you. Here's the third one [12 sec] [3] Does that remind you of any things you do currently?

S: well, economics really. (Uh hmm) Which part of the graph shows when price is rising fastest well that would be the area of the graph with the steepest slope, would it not? Might be Yes, would be

S: So without looking at the numerical values which I've just looked at [chuckles] (at the list), it would be there [3 minutes pause before lunch]

JE: Fine Okay and what was the lowest price that day?

S: [Pause] It would be about 59p.

JE: Okay, does that remind you of any earlier experiences?

S: Well, only economics O-level and A-level, frankly — but nothing else I suppose.... [8 sec] No.

JE: Good, thank you. Do you ever go to a restaurant when you er with a menu outside. [4]

S: No I mainly stand outside I don't go in.

JE: Ah. Why is that?

S: Well the only one I can think of is we've got a restaurant by the bus stop where I work, and I'm usually outside waiting for a bus and the menu's outside on the wall.

JE: Right, is that, that's in London, or.

S: ~~Yes~~ No. it's Margate.

JE: Could you choose a dish from that please?

S: [time] [-?] Chicken Maryland. [23.75]

JE: Okay, now supposing you've had your meal and finished and they say the amount of the service that you leave is up to the customer what would you do?

S: I'm always a bit narked when they do that I'm always a bit upset because I, um, — [be] If I just had one dish I don't know I with that sort of thing you know you always leave 50p you don't think about how much you've had, you're thinking more in terms of what would the waiter think is fair (right) or what would the waiter think is stingy you know. So if they sort of said that um any charge for service, service wasn't taken into account, then I'd just leave 50p or [...] 20 pence or something something like that.

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JE: Fine. What if the service was 10%, what would a 10% service charge be for that meal? [46]

S: Um [time] would be 32p.

JE: Right. Does that remind you of any earlier experiences?

S: Er ..... well only looking at menus and such, um maybe adding up what a full meal would ~~cost~~ be

501 (interruption) J. [Excuse me a minute .. Oh hello T. [86/8] I won't be long]

S: Yes, you were saying — Well just adding up what a full meal would be (uh huh) so the only thing I'd be able to get there would be a coffee. and the chicken. which would be [twenty pee?] four pounds, two pee.

[time] oh the full meal's including the chicken maryland.

JE: Yes, just about except for coffee, yours right fine. Does that remind you of anything else, that ~~thing that you saw~~ seeing that, and so on.

S: Maybe a shop receipt or my mum's got an awful habit of adding up all the prices on a shop receipt when she gets home to make sure she wasn't, hasn't overcharged.

JE: Uh huh, and why is that an awful habit?

S: I don't know just just doesn't seem much point when you've got home and left the shop about 40 minutes ago you're just checking up just to make sure (yes) you can't exactly go back and oest hell out of the check-out ~~system~~ assistant can you?

JE: It would be difficult.

S: So she just usually walks round the house saying 'Ooh, bitch' and that sort of thing 'she's overcharged me 10p' (uh huh) 'Now, I know' ... That's about it

JE: Right, okey well that's all the questions I would like to ask you. Is there anything that you'd like to ask about any of the questions?

537 S: I was surprised there weren't any adding up and addition (uh huh) and multiplication (uh huh) instead of you know 3 or 4 numbers to add up that sort of thing I expected you to do that. I don't know why maybe, the because if I've got 4

numbers to add up by the time I've got to the third one I'm a bit confused... Or maybe even, cos this is what I did on this job interview they had a string of us long multiplication sums and then next door to that they had addition sums in the same format and then subtraction sums in the same format and it was a very bad photocopy and you know you couldn't see the signs so I multiplied them all (uh huh) and then obviously got two thirds of them wrong.

JE: Oh that was at the job interview, oh that's a dirty trick I think if its a bad copy (yes). Did you tell them that?

S: Well I enquired and about two inches above the sums it had a title you know and "multiply" underneath, "subtract" underneath and "add" - but because I was looking at the sums and not at anything above, I didn't see it [inhales: rueful laugh]. So I got the questions wrong and it was for a shop, it was ~~list~~ for Marks & Spencers and I didn't hear from them again [REPT ~]. So-

JE: Ah. Did you tell them that you'd had that difficulty when you

S: Yeah, Oh yeah. But y'know It's a standard application form with small test at the end which they'd given everybody so anybody who has difficulty in understanding their form, they obviously don't think I'm quite good enough

JE: You still have the right to an easy copy I think. (S: yeah) Yeah. Right. How do you feel about the way you're able to use

579 numbers in general these days?

S: I think I'm alright as far as I can see I'm okay using numbers in my head. I find I'm far more comfortable working out easy when I play golf and I'm working out my gross score and my net score you know my net handicap and my gross handicap in my head, rather than having to put it down on a piece of paper. Or if I'm playing darts you know

I remember having to do - sort of I had to do add together] three 17s you know, triple 17, and ...

So I think I'm alright doing single sums in my head. But it gets – um, I have [illegible] – it gets [illegible] more I have to write things worse the more ~~I do~~ on paper. And um I find the first time I do a sum I hate it and the second time I do it

600 it's not quite so bad ..

And as soon as I've actually figured out the simplicity involved in it. And finding out how actually, how simple it really is

603 - Once I've done that, then I'm all right. I'm coasting.

JE: Good, good. Is there anything you'd like to say about [the way the interview took place?]

APPENDIX U1 Illustration: Sam

Interviewee no.17, here called "Sam", was 20 years at entry, male, and one of the three black students interviewed. With O-level Maths and a place on the Economics Track of the degree, he was better qualified in Maths than many of the interviewees. He provides an illustration of feelings boredom, and anger, about maths.

Sam describes himself more than once during the interview as someone who hasn't "looked at Maths for years" (transcript, pp.8, 22, 23.) Within Maths, he distinguishes "easy topics" like pie-charts, from topics he "hates", such as percentages (p.8). In response to my showing him Qu. 2 [10% of 6.65], he tells a story:

> S: I used to hate these ... [JE: ... Why was that?] I don't know - just used to hate them....
> JE: What do you think when you see a question like that?
> S: ... a complete blank ... I haven't done Maths for 3 or 4 years really.... [5 lines]
> Well, I know to do it - just put 10 over 100, and cross multiply, get the answer that way....
> JE: And what answer would you get?
> S: Dunno ... .65 ... [4 lines] ... if I was in an exam, I wouldn't do that - I would say it's more from conditioning, it's .65. I don't know how I know - it's just .65....
> JE: Um, right. Does it remind you of any earlier experiences, seeing that?
> S: Yeah, I had to do that for homework... [JE: When was that?] Oh, 'cause I always had a problem with Maths, my teacher [...] gave me thousands of 'em to do, and I used to hate doing them, I used to leave it 'til the night before he came ... [3 lines]
> Well, although I didn't like doing maths, he used to come at 8 o'clock in the morning, [..] hate getting up in the morning. ... [JE: He came to your home?] ...
> Thing was he told my mum and dad about me at school [where the tutor was employed as a teacher], [JE: ...] about my friends ... [5 lines] - in the wrong crowd and all this ...
> JE: So how did you feel about that?
> S: I used to hate him for it ...
> JE: [...] When you think back about the work that you did with him, [..] are you able to think of that separately from the other things he did, or is it all in one sort of memory?
> S: It's in the one memory ... [1 line]
> I didn't used to listen to my mum and dad, I didn't used to listen to him, every week it was the same [...] ... if I didn't do my homework, then it would start, bitchin' on all the time [...] rabbit on about the school and that....
>
> (interview transcript, pp.8-10)

This subject expresses a great deal of anger ("hatred"), towards the tutor, towards his parents, towards maths. Before the tutor came it was already the case that he "didn't like doing maths", but the additional anger and "hating" are <u>displaced</u> onto maths by the associations produced there. This sort of episode might help to explain hating maths, or at least certain types of question - through an association with the hateful "telltale" tutor. It might also explain "getting bored easily" - at least in maths if you have to do "thousands" of one type of question - and the "complete blank", which in turn explains his oscillation between different ways to do percentages in the interview Qus. 2, 4, 5 - and Qu. 18 in the questionnaire.

Let us consider his performance on the percentage questions:
- Qu.18 on questionnaire: omitted! he was one of the few students to do so, for reasons other than running out of time;
- Qu.2 on interview [10% of 6.65?]: ".65" (done mentally, see above); he says he "knows" it, by "conditioning" - maybe an imprecision, or an approximation;
- Qu.4 [10% tip, for meal costing £3.75?]: "75p" (done mentally); at first, this seems just wrong - even perhaps a second illustration of a faulty "rule": "when taking 10%, simply drop the <u>first</u> figure, and move the decimal point"; but perhaps he is following his own rule about tipping: "you can't go lower than 50p" (transcript, p.15; see Sec. 10.4(a));
- Qu. 5A [9% pay rise on £66.560, approximately ?]: "£5"; and
- Qu. 5B [9% pay rise, exactly ?]: ".594" (problem "set up" and multiplication done on paper; error and slip with decimal point; answer produced only with a great deal of help from the interviewer); when I press him about what it would be in money terms, he thinks for 20 to 25 seconds, before adding "pence". But he was not certain, since, on being probed again, he admitted that it "just looks wrong"; it is not completely clear whether his critical relection on the answer ".594 ... pence" was based on his positioning in SM (as I originally judged), or whether my pressing him perhaps led to a shift into practical maths (wageslips, etc.) - which led to his puzzling about the meaning of the "4", and/or to puzzling that the increase was (only) in pence.

However, his positioning is different for these problems: academic maths for Qu.2 (and probably Qu. 18); eating out for Qu.4; and interdiscursively for Qu.5. For that question, he uses both written school algorithms and an evaluation of his tentative answer which draws on his knowledge of current wage levels.

It is argued in Ch.11 that different discursive practices have specific emotional charges. Here, the main episode shows that negative affect is linked with school maths, especially the area of percentages, through displacement from the "hated" maths tutor, and the subject's parents. In this case, the main emotions are anger / "hatred", and resistance / boredom. The feelings combine to have fairly predictable effects: avoidance of that type of question in the questionnaire; forgetting of algorithms; and, possibly, the use of dubious algorithms. These "intervening" responses also have predictable consequences in terms of what might seem "cognitive" or performance outcomes: slow and halting calculations; and unreliable answers.

Thus, in Sam's account of the episode and his feelings about it, boredom with school work can be seen to have its roots in repetition ("thousands of 'em ..."), and resistance: "I didn't used to listen to my mum and dad, I didn't used to listen to him...."

APPENDIX U2 Illustration: Keith

Interviewee no.4, here called "Keith", was a middle class man, 23 years old at entry, with O-level Maths - though he had failed A-level Maths.. He was therefore among the best qualified interviewees in school mathematics - along with no.13, an ex-electrician, who had A-level equivalent in vocational qualifications, and Ellen and no.22, another woman, who had passed A-level maths. Before coming to college, Keith had worked in a hostel. In the interview, he attempted eight interview questions, with all but one (see below) done "correctly". But there are several problems where his responses are surprising.

For Qu.2 [10% of 6.65?], rather than giving the answer immediately as one might have expected with his qualifications, he asks "Can I work it out?", and after I offer him paper, says: "... divide by 100 [writes 0665], then I times it by 10 [writes .665] so [...] .665". This answer certainly is correct - but is that really how he would do it? He goes on to explain:

> S: ... I find it difficult to work things out in my head with confidence. I can do it I suppose, but I prefer to write things down in a way.... I wish I could, I felt more confidence in doing things in my head like that - but I, I don't....
> JE: [...] does that remind you of any, any other tasks, any early experiences?
> S: Umm ... it reminds me of [...] what I said earlier about doing numbers. I know how to work out percentages - it's just a matter of doing it [..] in that sense, I don't know if it frightens me or I just don't - it doesn't really grab me [...] I find it sort of, a struggle to [2 sec.] kind of get myself to it....
> (interview transcript, p.5)

Keith seems to be using the writing down (of 0665 and .665 only) as a sort of memory-aid (see Sec. 10.4(b)) for working through the steps of the calculation, not to "set up" the problem as 10/100 x 6.65, as do other subjects, e.g. Jean (see case studies). In the statement above, he appears to be saying that it is lack of confidence that makes him calculate in such a cautious way. However, on reflection, it seemed to me that he was positioned in a mix of SM and research interviewing (RI), that made him want to "display" to me the proper way to do maths. Thus what are sometimes called the "reactive effects" of the interview (or perhaps its "demand characteristics") can be seen as a result of the subject's positioning, including the practices called up. In Qu.4 [10% tip on a dish costing £3.81], he does the "same" sort of calculation in his head, immediately.

For Qu.3A [period of fastest rise in gold price], he answers "after lunch", which is not correct. In response to the contexting questions, he states that he doesn't remember doing graphs at school, but having "gone over it" in the last two terms has "refreshed my memory" - though "you have to be very careful with the lines [to] get the points right" (p.6). As for calculus, when he was in the 6th form, he felt "bewilderment, what it was all about, the actual purpose of it", and considers it one of the reasons he failed A-level Maths. But he feels he "grasped it a bit more" as a result of the Methods and Models course, especially by reading Morris Kline, Mathematics in Western Culture, the text.

The error in Qu.3A is surprising, again, for someone with O-level. Is it "just a slip", perhaps caused by inattention - or could it be related to the link between his "bewilderment" and learning calculus in 6th form at school?

For Qu.5 [9% wage rise on £66.56, A approximately and B precisely], his response for A, "about £6", is very close. For B, he answers "um, 9% [...] my mind went a blank then [...] £5.98, I think or £5.99 probably" (p.8). He explains that what happened was

> S: ... thinking about what I'd done, and if I'd done it right, then about the £66.56, I lost track of the decimal point, and then I decided, I went blank about what six times nine was for a moment [..]
> JE: ... does that remind you of any current, any recent tasks or any early experiences ?
> S: [3 lines] ... sudden block, I guess through not doing tables - I mean when I was a young kid sitting with my parents having to recite all the tables, but obviously I don't do that now, and I guess just through inactivity sometimes just remembering what a particular thing is, just where it's gone from memory what six times nine is, though it's not there on the surface, like it would have been, when I was at school, or when I'm doing figures every day ....
> JE: Did you do a lot of things with numbers with your parents?
> S: Um , up to a certain point ... I remember there was a point where I was at secondary school where I looked, my father said I'd lost him - he didn't do maths that way when he was a boy ... [4 lines] ... I think perhaps definitely after O-level, anyway, my father although he was an accountant, he couldn't, well - dealt with figures every day, he couldn't sort of, deal with the concepts we used [JE: uh huh] Calculus, he's never done, really hasn't got a sound grasp of it. Yeah, I mean, he's just sort of much more good at just sort of straightforward figure work, multiplication, percentages and all that sort of thing....
> (interview transcript, pp.8-9; my emphasis)

Here he presents his "sudden block" as a result of unfamiliarity, rather than, say, anxiety. Here, too, there is an association between A-level maths, his failure in it, and the "loss" of his father. Could this loss be implicated in his failure of A-level maths, or in his "forgetting" now?

For Qu.6 [best buy of two ketchup jars], I argue (see Sec. 10.4(c)) that he seems to have called up school maths to solve the problem, because he also admits that he never really "works it out" in the supermarket, because of his attitude to money: "It's just a matter of [...] assuming [...] economy with the bigger packet [...] quite difficult to work out things like that in my head ... " (interview transcript, pp.11-12). He then works out the problem, rather elegantly, using what I call the "LCD of quantities" strategy (classed as a version of strategy (5) in Sec.10.4(c)) - but it is somewhat artificial for him, given his not perceiving it as worthwhile to "make the effort" to do extensive calculations to save what are likely to be small amounts of money. This problem reminds him of workcards of simulated shopping that the pupils had to work through at junior school - which were "boring" (p.13).

To summarise, he is concerned about his ability to do calculations in his head, in particular percentages; these are things his father does well. Yet he "dread(s) the thought of having to add up figures, and just dealing with figures all the time", e.g. in the complicated calculations for rent arrears at his work (p.3); this was presumably the sort of thing his father had to do at work. In another context, Keith also dreaded the boring repetition in doing repeated workcards on the same idea at school - though he had "enjoyed great long sums" in junior school (p.13). Around the same time, he achieved a certain self-liberation from boredom, by delving into school library books when he was "held back" (because of his age):

> That thing of <u>solving a problem</u>, sort of apply what you know, try and sort of crack it, I quite like that, but you don't get too much of that in your life!
>
> (transcript, pp.13-14, my emphasis)

Is this a taste of "the mastery of reason" (Walkerdine, 1988)? Somewhat later, he finds calculus interesting - while he "lost" his father when he did it. Yet, he makes a mistake in a simple application of the gradient in Qu.3A.

He seems to exhibit a great deal of <u>ambivalence</u> in these passages: ambivalence about arithmetic at school; ambivalence about what his father does - much of it ("dealing with figures all the time") may be boring, but he would like to be able to do some of it, e.g. mental calculation; ambivalence about more advanced mathematical topics such as the calculus: it is interesting, but in doing it, he "lost" his father. As we move backwards along what certainly appears to be a chain of displacements, it begs the question: is ambivalence one of his overriding feelings about his father? Can his error on Qu.3A, and indeed his "bewilderment" about the calculus, be seen as related to his feelings for his father - identification with him on the one hand, and distancing or competition with him, on the other?

We can pose these questions - and speculate on them, but with the limited material available, it is not possible to give a satisfactory answer.

However, it seems clear that the signifier "lost" (of his father) is a key signifier, located at the intersection of at least two discourses. One sense of the word is of having to give someone up, not to be able to find them any more, emotionally; this would relate to the family discourses, from the point of view of Keith as a 16- or 17- year old school boy. The other sense of the term "loss" here is moving away from someone, leaving them behind, academically, intellectually; this would relate to school maths discourses and to Keith's positioning as relatively successful pupil within them.

In terms of <u>numeracy</u>, we note that he is able to do an <u>evaluation</u> of whether it is worthwhile doing a calculation to save a few pence in the supermarket, or even to make a saving in buying sports kit (problem 8): "You know, you're saving £5 - is that really a big saving?" (p.17). This seems to be related to his attitude to money, which in turn is related to his social class positioning: "I can never really understand payslips [...] it's my attitude to money, a bit blasé, really"; he is "quite trusting about payslips" (p.10). This can be contrasted with interviewee no.2, who was lucid about the importance of the "cash nexus" for people doing unskilled manual jobs (see the discussion of Qu.5 in Sec.10.4(b)).

APPENDIX U3 Further Analysis of Theme 3: Gender Differences in Performance Understood as Differences in Positioning within Practices

In Sec. 10.3, Theme 3 is analysed using results from problem 3. Here I use the results from problem 2, an "abstract" ten-percent problem: "What is 10% of 6.65?" To begin with, each student's response was categorised in terms of the method used - "mental" / quick, or written / laborious - and the correctness of the answer.

Considering first the method of calculation, 15 of the 22 subjects used "quick" mental methods, and 7 used methods that were written and / or "laborious": three middle-class men, two middle-class women, and two women of working class parents. One of the middle-class men used laborious mental methods - see Peter's case study in Ch.11, and another (no.9) used a method of decomposition (see NOTE 7, Ch.10) to calculate his ten-percent. Thus, for the method of calculation used, there do not seem to be substantial gender or social class differences (though of course the numbers are very small).

For correctness, see Table 10.3(a) which cross-tabulates correctness of answer, by subjects' gender and social class. It appears that there are gender differences of the sort that were observed in the quantitative analyses, in that 9 of 10 men were scored correct, and only 6 of 12 women; these will be explored below. As for social class, the noteworthy feature of these results is the much less good performance of those with "mixed" (see sec. 2.1.2) or unknown parental occupation: none of the four in this category got Qu.2 clearly right (including one man whose answer was difficult to categorise as correct or not). Given that this is the only "abstract" school maths question offered in the interview, this may say something about the way school maths is experienced by this group; recall that their performance on SM items on the questionnaire was clearly below the MC and WC groups. However, this needs further research.

In the statistical analysis of the whole sample of questionnaires, qualification in maths was found to "explain" to a substantial extent the gender differences in SM performance (see Ch.6). Here, therefore, Table 10.3(b) classifies the responses of the subjects, according to gender and qualification in school maths. Despite the small numbers, controlling for maths qualification seems to explain the gender differences in part: for those with "high" qualifications (O or A-level), there are no gender differences, but the latter remain for those with CSE or no qualification.

Also shown in Table 10.3(b) is the "predominant" positioning for each subject. Here 16 of 22 subjects were judged to have called up "SM" - school maths or college maths, and the other six to have a "PM" positioning, which included the numerate aspects of money and business practices. As set down in Sec. 10.2, an indicator for having called up school maths was using written methods, and/or expressing confusion as to the placing of the decimal point; thus all seven subjects who used written / laborious methods (see above) were classed as calling up SM (though one was considered difficult to classify - see NOTE 7a, Ch.10).

Four other subjects appear to have called up PM (usually work) practices of one kind or another: Donald (previously employed in money markets - see Ch.11), no.22 (a Saturday job as book-keeper), no.2 (betting) and no.1 (an industrial nurse who helped workers sort out wage slips). All of these did the question quickly and in their heads, confidently and correctly, except for no.1: "not sure ... 66p" [approximately correct].

It is worthwhile considering two examples of subjects whose positionings are difficult to determine. Alan (no.7 - see Ch.11) enunciates the rule "... ten percent, I always know you just move the decimal point"; this is ambiguous as it could be used either in practical maths or in school maths. However, just before this, he has said:

> S: Except if you'd given me, say, nine percent or eight percent - er, I would probably have to think again how to work out percentages, probably have to go into a book and [] it out how to work out a percentage again.
>
> (interview transcript, p.5)

Therefore, because his source of ideas as to how to calculate a "new" percentage was a school maths textbook, he was classed as calling up school maths.

Even more difficult to classify was no.9 (previously a stockbroker) who used a method of decomposition (see NOTE 7, Ch.10). After completing his calculation, as part of his response to contexting question (C): "Does that remind you of anything you do these days?", he offered:

> although I'm practising at home constantly, in this environment I'd like to have my calculator and my notes. That's why I divided it up [i.e. decomposed it] like that....
>
> (interview transcript, p.6)

In "this environment", he completes the calculation using decomposition, which is often associated with non-school contexts - since it can be appropriate for mental calculation, and can be used when a school algorithm is not known or forgotten. However, the key to the discourse he calls up is his perception of what "this environment" involves: he would like to have his notes - which presumably are notes from school (or from tutoring). Also later in the interview (while discussing Qu.6), he says more about what this means:

> S: My god, in these conditions, Jeff, one gets extra nervous ... I can't ...
> JE: You're feeling that, are you?
> S: A little tense, because I'm doing it under, almost, in front of a maths lecturer....
>
> (interview transcript, p.14)

Thus, "these conditions" are "doing it in front of a maths lecturer" - that is, academic maths / testing. Therefore, I classed this student as having called up "predominantly" school maths. It would be interesting to explore his possible interdiscursive positioning in school maths and other discourses, especially in view of his history of mathematics study, but that would require further data.

Thus, when we look again at Table 10.3(b), we can see that the pattern of gender and qualification differences in performance seems to hold only for those who called up academic maths; there appear to be no such differences for those calling up "practical maths" (PM) - though there are only six so classed; indeed five of their answers are correct, and one approximate. Thus, there are suggestions here - though the numbers are very small - that those who called up PM had a higher level of correct performance, and also did not display the pattern of differences related to gender and qualification in maths.

To sum up, when we consider "correct" performance for Qu.2, there initially appear to be gender differences, but these are partly explained by differences in qualification in maths - for the high-qualified (O-/A-level) only. That is, there still appears to be a lower level of performance among low-qualified women students. However, this relation of performance to gender and qualification differences appears to hold only for those positioned in academic maths - but not for those who were judged to have called up various non-school practices within which to address Qu.2 (though the numbers are very small). Thus we can see that gender differences in performance may depend at least to some extent, on the practices in which the subjects are positioned.

APPENDIX V1 Gender Differences in School Mathematics Performance

A recent overview produced by Willis (1989) argues that there has been a constantly changing definition of "the problem". In the 1950s, she argues, there was not seen to be a problem. In the early 1960s, the problem was seen as "Why can't girls ...?", and was answered in terms of ability. For example, Maccoby and Jacklin's (1975) review of the sex difference literature concluded that one of the few differences that still existed was male superiority in "mathematical ability". By the early 1970s, the problem was "Why don't girls ...?", and the answer was couched in terms of attainment - and biological determinism gave way to explanation in terms of social class, race and gender differences in educational experiences. By the late 1970s and early 1980s, the question was becoming "Why won't girls ...?", through the emphasis of Fennema and others on affective factors (see below).

This account of the gender differences research is succinct and elegant, but there are two problems with it. It does not ask "Do girls really perform less well in maths?". And, even if the answer to that question is "yes", the question "Why won't girls ...?" is posed in terms that risk appearing to blame the girls for their attitudes, or anxiety, or whatever affective "deficit" is considered to explain the performance deficit; see e.g. Walkerdine et al. (1989).

A group centrally involved in setting the agenda for the American research on gender differences in mathematical performance (or "achievement") when I began work on this project was Elizabeth Fennema and her colleagues. For this reason, their ideas are used in structuring this review, with later work being drawn on where relevant. According to Fennema, during the 1970's there were two somewhat different emphases in this research, namely:
(a) a reexamination of if, and where, sex related differences still existed; and
(b) a deeper look at possible explanations for any differences that exist (Fennema, 1979, p. 390).
I now look selectively at debates around these issues.

(a) Do gender differences exist, and, if so, where?

On the first point, Fennema concluded that there were no sex related differences evident in elementary school years, for all cognitive levels from computation to problem solving. After about age 12 or 13, if differences did appear, they tended to be in the males' favour, particularly on tasks involving higher level cognitive skills (Fennema, 1979, p.390).

Fennema and her colleagues went on to make a crucial observation about the comparison of populations of males and females on achievement tests such as the first International Study of Achievement in Mathematics, which showed males in 12 countries at the end of secondary school scoring higher both on computational and on verbal problems in all populations (Husen, 1967). First, these studies ignored the fact that males had studied more maths at school; and second, that

> the single most important influence on learning mathematics is studying mathematics.
>
> (Fennema, 1979, p.391)

This led to attempts to control for - and indeed to focus on - "participation", or the number of maths courses studied, in subsequent studies (e.g Fennema and Sherman, 1977). It was this move that provided the basis for the change in the definition of the problem, in the US at least, to that of "Why won't girls?", and a shift to emphasis on affective factors, as argued in Willis' (1989) account above.

Meanwhile, in the UK, concern has been expressed somewhat more recently about lower female performance in two contexts. First, girls have tended for some time to receive lower grades than boys in GCE and CSE mathematics exams (Burton, 1986, pp.4-5; Royal Society and Institute of Mathematics and its Applications, 1986, pp.8-13; HMI, 1989, Ch.1). Second, the results of national surveys using standardised tests, notably those on primary and secondary school maths carried out by the Assessment of Performance Unit (APU), have been interpreted by many to confirm this picture of lower female performance (see below). In this context, the concept of "participation" has been used much less than in the USA to explain gender differences in maths performance. Partly, this is because of institutional differences: all students in the UK have normally taken some maths to age 16. Perhaps researchers are also less sanguine about the positive influence on performance of time spent in a maths classroom per se (e.g. Burton, 1986, p.4).

In the UK, one of the three cohort studies of children born since the 2nd World War is the National Child Development Study (NCDS). (The ALBSU analysis of the 4th follow-up of this study, when panel members were aged 23, is discussed in Sec.2.2.) The NCDS found very slight differences in standardised tests of mathematics in favour of boys at ages 7 and 11. There was a slight pulling ahead of the boys at age 16, but the summary raises the question of whether the "small" difference

> is compatible with the considerably larger number of boys who enter, and, among those who enter, who pass public examinations in mathematics. It may be that there is still much female ability in this area which is not developed by schools.
>
> (Fogelman, 1983, p.40)

The Assessment of Performance Unit (APU) carried out six primary and secondary mathematics surveys in the years 1978 to 1982 and 1987. It produced a wealth of information using tests - written and practical - on five areas of content - number, measures, algebra, geometry, and probability and statistics for the primary surveys, and on three outcomes - concepts and skills, problem-solving, and attitudes. Each survey involved about 500 schools and 10,000 pupils; see also Foxman et al. (1985) for the full details on the 1978 to 1982 surveys. The main findings with respect to gender differences were summarised as follows:

1. The profile of findings across some topic areas remains relatively constant between ages 11 and 15; for example, boys perform best relative to girls in applied and practical areas like measure and rate and ratio - while girls do best relative to boys in areas like computation and some aspects of algebra.
2. The differences in performance are minimal in most topic areas - except in the top 10 to 20% band, where the boys outnumber the girls by about 3 to 2; this is <u>not</u> matched by a corresponding preponderance of girls over boys in the bottom band.
3. The main differences in performance are already established by age 11. (Joffe and Foxman, 1986)

In assessing the results of large scale surveys such as the above, which aim to assess whether there are "real" gender differences in mathematics performance among school pupils, it is relevant to remember the following points. First, differences such as those to do with gender are often based on average scores, and so may draw attention away from within-group differences which may well be substantial. Second, the differences may not be statistically significant. And, third, even where a sex difference is statistically significant, its <u>size</u> in terms of test-score points may be small, and it may be less than other differences, such as those between regions, as in the APU primary surveys (APU, 1982, pp. 72-73; see also Walden and Walkerdine, 1985).

In any case, the above summary of the APU findings seems to answer the first question for the UK at that time by saying that there <u>were</u> gender differences in performance, and that they were evident from age 11 - though this last claim was certainly challenged (see NOTE 11, Ch.2). However, although the findings of a predominance of boys in the higher performance bands might seem to explain boys' preponderance in the higher grades of exam passes in the UK, the <u>caveat</u> from Fogelman quoted above, should be remembered.

Walden and Walkerdine's later work (1985) points to an alternative explanation. Contrary to the consensus, they did not even find that boys <u>were</u> pulling ahead after age 11. In a study of 5 classrooms in a London secondary school (1985, Ch.3), they found a few gender differences in favour of boys at age 11, but the differences between tutor sets (classrooms) were at least as great. At age 14, the girls were superior in all components of the mock examination (test, course work, and investigations), again with large differences between tutor sets. The results of this small-scale study were not considered by the research community to undermine the pattern established by the APU and other results, but they did contribute to an emphasis on questioning the "reification of the categories 'girl' and 'boy' [which] help to produce explanations which favour sex-specific characteristics" (1985, p.23), and on producing other sorts of explanations. Walden and Walkerdine themselves turned their attention to the way girls' good performance was discounted in classrooms - e.g. by the tendency for girls to be entered less often than boys for the higher status, more "demanding" examinations, i.e. GCE O levels (rather than CSE's), and A levels (1985, pp.44-45). They based their work on classroom observation, teacher interviews and pupil interviews, as well as test results; see further Sec.7.5 below and Walkerdine et al. (1989).

This tendency to enter girls for "less demanding" examinations may have been supported partly by arguments made by Shuard and others that girls at age 10 and 11 excelled largely at the "lower level" computational items, whereas boys usually produced superior performance in subcategories for "applications of number", "rate and ratio", and several to do with "measurement" (Shuard, 1986, pp.32-33; but see Walden and Walkerdine's criticism of the age 10 results (1985, pp.28ff.)). However, an update of the reports on the APU research sheds further light on these issues (Foxman and Joffe, 1990; Foxman, 1990, personal communication). First of all, the results on the APU Problems and Patterns (abstract problem-solving) tests, which were run fully only since 1981, show girls to be slightly ahead of boys both at 11 and (perhaps slightly more so) at 15; this suggests that girls excel not only at "low-level" mathematics.

Second, the APU now presents its results on gender differences not as a superiority of boys or girls for each individual content area, but rather as a progression of relative advantages, ranging from girls' "best" area relative to boys - computation, to boys' best area - measures (see e.g. Joffe and Foxman, 1986, p.48). This approach allows researchers to focus on a comparison of areas, rather than gender groups, and to ask why these areas are the setting for a female or a male advantage.

(b) Explanations for putative gender differences

Fennema and her colleagues' "generic" model for explaining gender differences, or indeed differences more generally, in school maths outcomes is discussed in sec. 2.3.1 of the text. Here, I discuss more fully the affective and the social ("external") variables.

(i) <u>the affective</u>: Fennema (1979) argued that "all of the affective variables which appear to be salient [for the explanation of gender differences] are related in some way to the stereotyping of mathematics as a male domain" (1979, p.394). Thus, in the battery of nine scales making up the Mathematics Attitudes Scales, one of the scales was "perception of mathematics as a male domain" (Fennema and Sherman, 1976 - see also Sec. 3.3). Fennema and Peterson (1985), however, highlighted three other affective components:
- confidence in one's ability in mathematics;
- perceived usefulness of mathematics;
- one's pattern of causal attribution for successes and failures in maths: e.g. males seeing success as due to

ability, and females perceiving it as due to other factors such as luck, leading to "learned helplessness".

Affective variables are discussed further in Ch.3.

(ii) the social: Various factors in this area which have been suggested as important for explaining possible gender differences by US and British researchers will be sketched out here. Fennema (1979) saw this area as including the three domains of home, school and community, which are characterised in commonsense terms, but we have to expand her discussion somewhat because it focusses mainly on school variables, and notably on teachers. The home includes influences from the student's family - especially parents; and the community includes a range of factors from peer influences to cultural "stereotypes".

Teachers can influence gender differences in mathematics learning and course-taking, in many ways; for example, in terms of differential encouragement and reward (Fennema, 1979; Fennema and Peterson, 1985; HMI, 1989); or in terms of the amount of attention given and the number of verbal contacts initiated (Stallings, 1985, p.208). And teachers' own feelings, for example anxiety about maths, can affect the pupil's own approach to the subject (Walden and Walkerdine, 1982). Of course, teachers also play an important role through their definition of what aspects of the curriculum are important (Shuard, 1986), the quality of their teaching, and the sorts of learning and working strategies they encourage children to use (e.g. Scott-Hodgetts, 1986).

Interestingly, none of these researchers mention the importance of the student's position in the family and relationships with siblings, e.g. feelings of competition. Family size was found to correlate with mathematics attainment in the NCDS, but it is difficult to interpret what this might mean: summary of the NCDS findings suggests that family size might be associated with parental attitudes (Fogelman, 1983, p.42), which are already included in the conceptual maps of many of these studies. Nor is the influence of peers and peer group culture very much emphasised in this literature (but see Leder, 1985). Students' peers were found to be the least important of all influences on enrolment decisions, according to student's ratings in Armstrong (1980). However, students may have under-estimated the influence of peers (Chipman and Wilson, 1985, p.308).

Cultural beliefs include those about mathematics - e.g. whether it is seen as "a male domain" (see above) and whether it has "mystique" (Tobias, 1978), and also stereotypes about what are acceptable goals and behaviours towards maths for young men and women. Textbooks can be scrutinised for differences in their portrayal of females and males (e.g. Northam, 1982). Walden and Walkerdine draw attention to "contradictions" in which girls are placed, where there are considerable pressures on them (not only, of course, from school) to behave well and responsibly, and yet breaking classroom rules is taken by teachers to be evidence of the sort of "natural flair" that is required for mathematics (1985, ch.6). Isaacson (1986) discusses more generally the sorts of "coercive inducements" and "double binds" to which girls are subject, and which affect their "freedom" to choose maths and science subjects. Some researchers also consider the effects of certain relatively "objective" features of society - such as gender divisions in labour markets (Eccles, 1985, p.312).

Summary: Do gender differences in mathematical performance exist? The answer is presumably changing over time, and it seems to depend on the society, on the age of the pupils (perhaps), and in particular, on the areas of the curriculum tested, as the APU studies have shown. Indeed it is conceivably possible to produce gender differences of considerably varying sizes and directions, by a judicious choice of questions from particular areas of maths (e.g. Goldstein, 1987).

This literature review has also noted the range of explanations that have been advanced for gender differences in maths performance and "participation", the taking of maths courses, especially in the research led by Fennema and her colleagues. It has emphasised the importance of affective differences, and social processes in school, home and community. However, the difficulties involved in finding adequate measures for many of the latter variables in research using questionnaires have been emphasised (in the main text).

APPENDIX V2 The Basic Skills Accreditation Initiative Survey

The results of this survey were reported in a press release "How Well Can Adults Add Up?" in Oct. 1990. The methods and results will be reported only briefly, since they are mostly consistent with those of the first two surveys (see NOTE 10, Ch.2).

The questions returned to the "test" format used in the ACACE study, with one exception. As in the earlier survey, there were questions on money - simple operations (ilustrated below) and percentages, deciding which number is bigger, reading a timetable, and reading graphs. But there was also questions on value for money in shopping, and a set of problems on measuring, including one self-rating question - on the respondent's understanding of "area". Another innovation was that the questions tended to be arranged in groups of three or four, and to be preceded by some remarks which put the problem in some sort of "context", and which smoothed the flow from the previous set of questions. For example, Qus. 1 and 2a asked respondents about going shopping - whether they made an estimate of what the bill would be, and how they know they will have enough money at the checkout; Qu.2b asked them if they could work out the exact total, and to do so for three items (£7.50, £2, and £15); Qu.3 asked for the cost of 12 chocolate bars at 30p each, and Qu.4 the change expected from a £10 note used to pay for these.

The results were broadly similar to those reported by the ACACE, for example on those questions dependent on simple operations with money. In addition, according to the press release, 59% could not work out 12% interest on a loan of £6000, and 47% could not calculate (15%) VAT on £80. 20% said they did not know what was meant by the term "area", and a further 20% were unsure; 39% gave the wrong answer for the area of a wall 12 ft. by 8 ft.

These results tend to confirm those of the ACACE study, and to raise questions again about the ALBSU analysis of the 4th NCDS follow-up - notably about the reliability of the performance measure, and the dependability of the results.

APPENDIX V3 Controversy in Anxiety Research in the 1950s and 1960s

A review by Biggs (1962) pointed to ambiguity and disagreement in the literature of the 1950s as to whether anxiety was a sort of "anxiety-proneness", which could be considered as basically a personal characteristic - or a "stimulus", depending on the nature of the situation, as well as on the individual's characteristics. In the first case, it might be considered a "drive" - as in the work of the Iowa School of Spence et al. (e.g. Taylor, 1953), or a sort of "conditionability" or arousability (e.g. Eysenck, 1957).

In the second case, the context was considered more important - as in the work of the Yale School e.g. S.B.Sarason, G. Mandler, I.G. Sarason et al. (e.g. Mandler and Sarason, 1952). The Yale psychologists were sceptical that anxiety could be considered a <u>general</u> trait for a particular person. Therefore, they resolved to study <u>specific</u> anxieties, as a response to a stressful situation. They further claimed that different types of anxiety led to different effects on intellectual performance (Sarason, 1957). The first anxiety they studied in detail was test anxiety, an aspect of achievement anxiety or fear of failure (Mandler and Sarason, 1952).

At the same time, work on "motivation" amongst psychologists had been dominated for twenty or thirty years by "drive theories" originating the work of Cannon and Hull, and continuing with researchers such as Spence. Here motivation was considered to be produced by the reduction of a biological drive, e.g. hunger: a "motive" was anything able to reinforce a change in behaviour, to make the organism learn. In the post-World War II period, however, there developed research programmes where affect, rather than tissue needs, was seen as a basis for motives. The foremost of such programmes focussed on the "achievement motive", or the "need for achievement" ("sometimes called "nAch"), though it also considered other motives such as the "affiliative need" (McClelland et al., 1976). Here a "motive" was a learnt ("secondary") result of pairing cues with affect, or with conditions producing (a change in) an affective state.

For example, a toy might lead a child to expect novelty; if confirmed over several occasions, the child will experience pleasure (positive primary affect); when next a toy is presented, the child may experience a state of anticipation (positive secondary affect); this state of anticipation provides the motive for the child to respond by playing with the toy ("approach"). If on the other hand, the novelty is not confirmed, the child may experience frustration (negative affect), and become turned off toys, leading to "avoidance" of them. (McClelland et al., 1976).

Atkinson and Litwin (1960) attempted to reconcile the ideas of the "achievement motive" research with the Yale School's ideas about test anxiety. They argued that "nAch" could be considered as a measure of the strength of a motive to approach success, whereas test anxiety could be seen as a measure of the strength of a motive to avoid failure. They found a small negative correlation (not statistically significant) between nAch and test anxiety, and a number of subjects that were either high on both measures, or low on both. This confirmed their idea that nAch and test anxiety were not measuring the same thing.

These latter ideas were drawn on by Horner (1968, 1972) in her work on "fear of success" in women; see sec. 3.2.4.

APPENDIX V4 Research on Dimensionality of the MARS

Brush (1978) studied 54 to 70 students in each of the Humanities, Social Sciences, and Physical Science in a private coeducational college in the USA. She used principal components factor analysis with varimax rotation, on a 94-item version of the MARS, and produced two dimensions. The first involved 45 items, such as Qus. 14 and 48 (see sec. 3.3.2 or APPENDIX P4); she called this "Problem-solving anxiety". The second was called "Evaluation anxiety", and loaded on 31 items, such as Qus. 54, 72 and 74. Brush's dimensions, however, do not quite correspond with the distinction between practical maths vs. school maths activity. Some of the items she classifies as indicative of problem-solving anxiety may be ambiguous in my terms, e.g. Qu. 14, and evaluation anxiety may of course not include all those activities that form part of school maths, e.g. Qu.26.

Brush's two factors were highly correlated with the same students' results on the 50-item STABS (Suinn's test anxiety scale): r=.57 and r=.72 respectively; the size of these measures suggest that the STABS may be measuring the same feelings, to a considerable extent, as the MARS, especially in the case of what Brush called "Evaluation anxiety". However, she found that, while the three subject groups expressed similar levels of test anxiety, they reported considerably different levels of maths anxiety (as measured by total MARS score, and by each factor) - even when test anxiety was controlled for. Thus she concluded that "the

MARS is measuring anxiety above and beyond the uncomfortable feeling most students have towards tests" (1978, p. 489).

Rounds and Hendel(1980) posed the question of the dimensionality of the MARS, thereby querying Richardson and Suinn's claim that the test was unidimensional. Their study used 350 female participants (average age - 36) in a mathematics anxiety programme at a large Midwest US university. It was based on a principal axis factor analysis of the MARS, with both oblique and varimax rotations (that produced very similar results). They considered an item to "load" substantially on one of the two factors if it correlated > .30 with that factor and < .30 with the other. The two "factors" produced can be described as follows:

Factor 1 - named mathematics test (or course) anxiety by the researchers: accounting for 31% of the total variance (of scores on all items), loading on 42 items. About one-third of these reflected apprehension about anticipating, taking, and receiving the results of maths tests, while two-thirds referred to activities directly associated with maths classes and courses. Examples: Qus. 26, 54, 74, 81. (See sec. 3.3.2 or APPENDIX P4.)

Factor 2 - named numerical anxiety: accounting for 8% of the variance, loading on 44 items referring to everyday concrete situations requiring some form of number manipulation (such as addition and subtraction). Rounds and Hendel found that slightly over a half of the 44 items refer to practical skills necessary for making money decisions, a quarter refer to a wide variety of practical situations, and about a quarter refer to the use of elementary arithmetic skills with no apparent context of application (p.142). Examples: Qus.10, 14, 48, 64.

Other researchers have found basically the same factor structure of the MARS. For example, Alexander and Cobb (1984) in a study of almost 200 college students found two similar factors accounting for 33% and 7% of the variance respectively.

Resnick et al. (1982) studied a large undergraduate population (n > 1000), mostly aged 17-22, at a northeastern US university with a selective admissions policy. They found generally low levels of anxiety as measured by the MARS. Using principal components analysis, varimax rotation, and a criterion of .40 for "loading", they found three factors:

Factor 1 (32% of variance): loading on 19 items and named "evaluation anxiety". Examples: Qus. 72, 74, 81; see sec. 3.3.2 or APPENDIX P4.
Factor 2 (5% of var.): loaded on 4 items and named "social responsibility anxiety". Examples: Qu. 87 and 98.
Factor 3 (4% of var.): loaded on 7 items and named "arithmetic computation anxiety"; six of seven items are "abstracted" from any context. Examples : Qus. 14 and 47 (the only one with context specified).

Plake and Parker (1982) themselves selected 24 items (from the 98 on MARS) which satisfied the criterion of measuring "anxiety in a statistically related situation" (p. 552), and administered this revised MARS to undergraduates enrolled in introductory statistics courses at a large urban midwestern university. They then performed a principal factor analysis, with varimax rotation, which produced two factors : "learning mathematics anxiety"(16 items) and "mathematics evaluation anxiety"(8 items). (Each of the 24 items loaded .50 or above on one and only one of the factors - suggesting perhaps that the items were selected to produce such a result!) Almost all of the 24 items included in the two factors relate to Rounds and Hendel's "maths test / course anxiety". The difference between the two factors may be valuable for diagnosing and countering statistics class-related anxiety, but perhaps not so crucial for the discussion of the <u>context</u> of anxiety here.

Ferguson (1986) formed a scale comprising 10 items each from Rounds and Hendel's maths test/course and numerical anxiety dimensions, plus 10 new items aiming to measure "abstraction anxiety", and administered this to students (n = 365) in mathematics courses, including remedial classes, at a large community college in the US southwest. In two different factor analyses, Ferguson found that the first factor loaded on the items created to measure abstraction anxiety, while the second and third factors loaded on the numerical anxiety and maths test/course anxiety items. Ferguson argues that, since abstraction anxiety relates to the sorts of mathematics topics that are introduced in the early teenage years - which is the same time as when gender differences in mathematics performance are claimed to arise, it is worth studying abstraction anxiety. It is important, however, to point out that Ferguson himself produced this new abstraction anxiety factor: by adding 10 new items produced to measure this in a 30-item scale, he virtually guaranteed the emergence of a separate factor.

Rounds and Hendel's factors are much the same as Brush's, except that her "evaluation" anxiety is named "maths test/ course anxiety" by them; and her "problem-solving anxiety" seems basically to overlap with their "numerical anxiety". (see NOTE 10, Ch.3) Also, Resnick et al.'s Factor 1 is similar to Rounds and Hendel's "maths test or course anxiety"; and the former's Factors 2 and 3 cover many of the same items as "numerical anxiety" - though not as many relating to "money" contexts. It may be noted that Rounds and Hendel's two factors loaded on many more items, since they used a less stringent criterion for "loading" (.3 rather than .4). Also, Resnick et al. suggest that the emergence of their Factor 2, "social responsibility anxiety", may owe something to the fact that they used the 98-item verson of MARS, whereas Rounds and Hendel had been provided inadvertently with a 94-item version, which lacked Qus.95-98! This shows the dependence of the results of a factor analysis on the concepts used by the researchers, on the set of items which is factor analysed, and indeed even on accidents.

APPENDIX W1 Utilitarian Studies of Work Contexts

The study carried out at the University of Bath (1981) for Cockcroft devised two concepts: a STIM (specific task incorporating mathematics) and a MIST (mathematics incorporated in specific tasks); the latter was "the abstraction of the mathematical procedures used in the STIM" (1981, p.12). The researchers produced some interesting descriptions of STIMs (e.g. the example from quantity surveying, p.15). They noted little evidence of the use of school maths methods in work, and documented the wide variety of methods used: these methods were often idiosyncratic - and sometimes difficult for the researchers to understand!

Their conclusions included a comment on the role of repetition of a task in leading to familiarity, and to "facility with number" (p.112). They also observed that, at work, it is facility and / or speed in numerical work, as well as accuracy, that are valued - rather than elegance, as in school maths. Thus there was a recognition of different values and goals in the use of mathematics on the different contexts. However, the basic characterisation of <u>context</u> was a task, a STIM. Therefore, though the tasks were often very fully described in terms of their basis in work, they were still seen ultimately as embodying or "incorporating" mathematics - just as in Sewell's work. It will be noted that both of these views still see <u>transfer</u> of learning from school to work as relatively unproblematical: after all, if the task "embodies" or "incorporates" mathematics, the first requirement must be just to "recognise" this.

Other studies with adults have been done on a similar basis, e.g. the London into Work project; for a critical summary, see Harris (1991a). This study used questionnaires with two sorts of items: closed questions of the form "How often do you ...?", for each of about 40 skills for each of four areas, including "basic calculations" and "problem solving" - with no context specified; and open-ended questions, which sought descriptions of the contexts in which the school-leaver respondents used the previously specified "skills". Thus a methodological division into question types mirrored a theoretical separation of the task and the context (as tends to be found in all studies using N0 or N1 views of numeracy). With a sample size of 1000, there was also a great temptation to analyse the more tractable closed-ended questions first.

However, Mary Harris managed to work with both types of data to produce some well-rounded findings (Harris, 1991a). These often revealed that the language used by school-leavers to describe what they did actually differed from that of the researchers with their views of tasks as "essentially" mathematical and their characterisation of them in abstract terms. For example, Harris relates the case of one job holder who when asked about the use of percentage calculations from the Basic Calculations questionnaire denied that she used them; when asked how she dealt with irate customers under the Communication Skills questionnaire, however, she explained that they were usually angry because of the prices of suits in the outfitters where she worked and that she calmed them down by "knocking 15% off" (Harris, 1991a, p.136). This was one of the many examples of what might be called the "No Maths Here - We're Practical" position taken by so many subjects in these researches, and by so many members of the population at large. This example demonstrates the discontinuity between the ways activities are perceived and described by practitioners, and by researchers.

APPENDIX W2 Ethnomathematics: Paulus Gerdes

Paulus Gerdes (1985, 1986) writes from the point of view of commitment to post-colonialist struggle in Mozambique. He sees an emancipatory mathematics education as necessary for two sorts of reasons. First, it is necessary to be able to "problemise reality" (Freire, 1970), so that social practices, etc. can be scrutinised and possibly changed; much of this critical activity requires reasoning that can be shown to be mathematical. (Gerdes (1985) gives many interesting examples.) Second, many of the everyday activities carried out by Mozambicans can be shown to involve "frozen mathematics" (1986). In response to the recurrent conundrum as to whether, say, a basket-weaver reproducing "geometrical" patterns is "doing mathematics", Gerdes answers:

> generally not [..] But the artisan(s) who discovered the technique did mathematics, developed mathematics, was (were) thinking mathematically.
>
> (Gerdes, 1986, p.12)

Gerdes provides a range of examples from practical activities that appear able to be "harnessed" for the purposes of mathematics education.

However, the analysis in terms of frozen mathematics is subject to several criticisms (Chevallard, 1990; Noss, 1988). One is that developing activities in a way that relies on laws of physics, of geometry, etc. does not amount to recognising them as such. Another raises the simple question of why it is so important to celebrate non-European cultures in the way indicated (Chevallard, 1990, pp.6-8).

Gerdes' views represent an attempt to emphasise the continuities between what is often seen as "European mathematics" and indigenous ethnomathematics and to celebrate many indigenous practitioners as "bearers" of mathematics - rather than pathologising them as "avoiding" of mathematics, or oblivious to it (as the utilitarians sometimes seemed to do).

Yet, despite the intents, Dowling argues that these approaches amount to a colonisation of African culture, since the hegemony of European culture is not challenged: people speaking from within that culture are allowed to label the indigenous practices as "mathematical". The

Mozambican basket weavers do not so label their activities, since they - like many of the practitioners described in APPENDIX W1 - do not speak in the discourse of academic mathematics (Dowling, 1991, pp. 105-110).

APPENDIX W3 Specification of Task and Context: Michael Cole et al.

For the Laboratory of Comparative Human Cognition (1978), the task serves as "the environment (or context) within which an informant's behaviour can be framed" (p.53). For a task to be "well-defined", it must meet the following conditions:
(i) specification of the goal of the activity, the initial conditions confronting the informant, and the set of elements in the task environment which the informant confronts at any time - i.e. all possible "stimuli";
(ii) specification of a circumscribed and predetermined set of behaviour allowable within the task environment; and
(iii) availability of a model specifying the relationship between various states of the task environment (the stimuli) and the various "moves" (the behaviour) of the informant within the task environment; or, failing that,
(iiia) the specification of relations between behaviour and task for systematic variations in a range of principally similar task environments; in practice, this means giving a subject more than one problem of the same type, or giving one problem to many subjects. (1978, pp.53-54).

Thus testing sessions (and lab experiments) show the following features:
(ia) the physical enviroment is highly constrained;
(ib) the person being evaluated is instructed to respond to certain specific features of the environment;
(ic) the tester constructs the stimuli and thereby is allowed to specify (correctly or incorrectly) the relevant stimuli;
(ii) the person evaluated is told the domain of behaviour that will be observed (making it highly probable that such behaviour will be emitted); and
(iii) the domain of behaviour is chosen to produce hypothetical relations with the stimuli presented.

To provide a contrasting setting - one not "designed to provide for displays of intellectual behaviour that are intentionally graded and controlled so that somewhere in the proceedings the individual has to fail" (Cole and Traupmann, 1979, p.34) - the research group set up an after-school cooking club, where the children's behaviour could be observed and recorded. The goal in the club was different from that of the testing situation: people came together to cooperate on a task, e.g. to bake a cake. (see NOTE 8, Ch.7)

The task environment in the cooking club could be specified to some extent. However, Cole and Traupmann were cautious: "we have failed to produce a general set of rules for identifying the environment-person relations of the sort that we have labelled cognitive tasks" (1979, p.41). For there were further problems. First,

> behavior is multiply determined; that is, the environment consists of several tasks co-occurring with <u>the</u> task in which a person (subject) is engaged. [...] We cannot provide a complete specification of all the tasks that Archie [one of the members of the cooking club] engaged in when we observed him (although ... such ethnographers as McDermott et al. (1978) can take that enterprise surprisingly far).
>
> (Cole and Traupmann, 1979, pp.42-43)

Second, in considering different contexts of performance

> the larger social context within which 'the same task' was embedded placed very different constraints on the individuals participating in the scene. As a consequence, the individuals were more or less free to change the conditions of the task, <u>even to the extent of making it go away</u>, depending on what social context it occurred in.
>
> (Griffin et al., 1982, p.114; my emphasis)

A third contribution reinforces the importance of goals in formulating a task:

> A 'whole' task thus becomes specifically a task considered in the context of the activity or higher-level goals that motivate it. Wherever there is a task, there is always a whole task. But in some settings, like the laboratory, the classroom, or wherever there is a hierarchical division of labor, the higher-level goals may not be under the actors' individual control. In other cases, the actors must formulate the instrumental relation between the goal of the task and the higher-level goals they are primarily trying to achieve.
>
> (Newman et al., 1984, p.192)

Thus,

> If we want to see how exposure to tasks that arise in an institutionalised setting such as the school affects behavior in other settings (the home, the supermarket, the office), <u>we must go to those other settings</u> to determine: (1) if the social organisation [..] there allows for the occurrence of the tasks that we have hypothesized are occuring at our source point; and (2) how people behave in the everyday contexts of occurrence of those tasks.
>
> (Cole and Traupmann, 1979, pp.42-43)

APPENDIX W4 Goal-Directed Action in the Dairy: Sylvia Scribner

The choice of a processing plant for the purposes of studying thinking in practical settings provided a solution to the problem (met in sec.7.4.1) of defining tasks / actions, since tasks tended to be based on "orders" for dairy products. It also promised to minimise the problems of ecological validity met in many lab-based cognitive studies.

The contributions of Scribner et al.'s research in terms of the relationship between cognition and context are to show that "knowledge and action have a reciprocal relationship": organised knowledge guides goal-directed action; goal-directed action also guides the acquisition of information and organisation of knowledge for the task at hand (Scribner, 1985, p.200). A number of findings from the study are relevant here:
(1) Skilled performance in practical problem solving was strongly related to the job. Differences in performing the experimental tasks were found between groups familiar with these or similar tasks from their work, and groups who were not (including the students and often, the clerical workers); they related to the use of different strategies (ways of dealing with the task), even more than to differences in accuracy.

(2) This implies that the difference between expert (skilled) and novice performance is in the greater knowledge and repertory of strategies available to the former. This allows the use of thinking which is adaptive in the sense that it leads to "economy of effort", or efficiency. This difference can be seen in specialised activities such as chess or music, and in commonplace tasks. Thus, "experience" can be seen as the active engagement of an individual in some activity involving "socially organised domains of knowledge and technologies, including symbol systems" (Scribner, 1984, p.14).

(3) Flexibility or variablility was a striking feature of expert performance: "skilled practical thinking [..] varies adaptively with the changing properties of problems and changing conditions in the task environment". In this respect, it "contrasts with the kind of academic thinking exemplified in the use of a single algorithm to solve all problems of a given type" (Scribner, 1984, p.39). Flexibility seemed to be related to task demands: e.g. the properties of the problem, the conditions in the environment, and the availability of a calculator.

(4) The "outstanding" result was that the use of maths at work was bound up with "knowledge of the things that the numbers signify". This recalls the idea of the "manipulation of quantities" (see sec. 7.4.2), and has powerful implications for the teaching of applied mathematics. (Scribner and Fahrmeier, 1982, p.44).

(5) There was a continuity in performance across school maths tasks and practical numerate tasks among the students.

On the other hand,

> blue-collar workers' higher-level problem-solving strategies on work-tasks were unlike the algorithmic procedures used in the classroom and displayed by students, and unlike those they themselves applied to paper-and-pencil computational tests. Most critically, [..] workers' solution processes on work tasks drew on domain-specific knowledge.
>
> (Scribner and Fahrmeier, 1982, p.42)

Thus, there was a discontinuity between the two "functional arithmetic skills systems" (made up of knowledge, concepts and "processes", p.38) used in the school-like, and in the work, contexts in the case of the manual workers. But these systems were not independent - as my reading of Maier's "disjunction" between school maths and folk maths would suggest - but rather "interpenetrating" in complex ways. Increased proficiency in practical settings takes the form of acquiring specialised functional skill systems, rather than increasing the abstraction of a single system (pp.43-44).

APPPENDIX W5 Arithmetic in everyday activity: Jean Lave et al.

(a) Lave's ideas and research

Jean Lave's book (1988) aims to contribute to the invention of an "outdoor psychology", that is capable of explaining social life outside of the laboratory and the school, where most of the evidence currently drawn on by psychologists has been produced. This will require insights both from psychology and from anthropology. However, Lave sees psychology and anthropology as sharing "functionalist" assumptions: society is seen as macrostructures; a consensus on norms, values, and "culture" more broadly, is maintained by socialisation or "cultural transmission". This leads to a duality in the view of the person as feeling and valuing (social in origin), an the one hand, and cognitive, rational (with an individual basis), on the other. This dualism relates to three polarities:
- culture vs. cognition (the basis for the established division of labour between psychology and anthropology);
- body vs. mind; and
- affect vs. cognition.

Lave examines the first two polarities critically throughout the book, but has little to say about the third.

For the main study, the research team spent about 40 hours with each of 32 female and 3 male Californian participants, 25 in supermarket study of shopping activity, and 10 in a study of dieting. (For further characteristics of the sample, see Lave, 1988, p.50).

The team produced several types of empirical material for the shopping study which will be the main focus here:
(a) observations of shopping activity in the supermarket,

focussing on the frequency of using calculations, and the proportion correct of the calculations _attempted_;
(b) a simulation experiment, with 12 "best-buy" questions similar to the sorts of decisions made in shopping, some presented using jars and bottles, others with the relevant information on cards (see pp.104-5);
(c) a standardised test of multiple-choice questions (MCQs) (the only research "instrument" for which details of questions are not given);
(d) an arithmetic "session", administered in the subject's home and comprising 54 questions including 4 on choosing the larger of two fractions similar to the ratios likely to be used in (a) and (b), and focussing on correctness of answers (as a percentage of _completed_ questions - pp.53-4), and use of flexible strategies; and
(e) and (f) questions on "number facts", single-operation arithmetic sums; and "measurement facts", on weight, volume and length units ; both presented orally.

There were a number of interesting results :
(i) Among the "school-maths"- type tests, there were low results for arithmetic session (immediately perceived by subjects as a test - p.54) and measurement test (59% and 66% respectively), and high results for MCQs and number facts (82% and 85%). But the number correct were _very high_ for best-buy simulation (93%) and for actual shopping (98% of questions _attempted_). (see NOTE 13, Ch.7)

(ii) In the supermarket, calculations were sometimes abandoned, with the subject taking " the bigger one, because it won't spoil anyway" (p.58), for example. Only once did Lave et al. record a subject as acknowledging that the choice was arbitrary (p. 158). (see NOTE 14, Ch.7)

(iii) In terms of correlations among the four "school maths" performance variables ((c) to (f) above), there were statistically significant correlations between all pairs of the four variables - except for that between arithmetic and measure tests (the two which had relatively low levels of performance, and hence higher variances). However, relating these school maths scores to the two more "practical" measures - best-buy problems and shopping (frequency of calculation), there were no significant correlations, except for one borderline value ($p=.03$) between frequency of calculation in shopping and measure facts.

(iv) There were significant correlations between scores on MCQs and arithmetic test, on the one hand, and age (negative correlation), years since school (negative) and years of school (positive), which would be expected in terms of theories of transfer; however, there were no significant correlations of the latter characteristics with number and measure facts, except for measurement facts with years of school (positive). (With only 3 men in the sample, gender differences could not be studied.)

(v) There was an observable contrast between the difficulties subjects had with the arithmetic test, and the familiarity with which they handled supermarket calculations.

For discussion of these results, see sec. 7.4.3.

(b) Best-buy studies

Lave et al.'s best-buy simulations can be compared with those of Capon and Kuhn (1979, 1982). Capon and Kuhn set up a cardtable outside two different supermarkets (see NOTE 15, Ch.7), and asked women shoppers (n = 150) to attempt two "best buy" problems:

(i) Garlic Powder - small 1.25 oz. = 35 gm. @ 41c (was 51c)
large 2.37 oz. = 67 gm. @ 77c

(ii) Deodorant - small 8 oz. @ $1.36
large 12 oz. @ $2.11

Pencil and paper were made available.

Using strategy (6), the unit prices for the garlic powder were 32.8c and 32.5c per oz. respectively; for the deodorant, they were 17c and 17.6c per oz. respectively. For strategy (5), the garlic powder problem required noticing a "very disguised" 2 : 1 ratio between prices (77c / 41c) and comparing it with a quantity ratio that was very close in size; the other involved a clear 3 : 2 quantity ratio.

Lave et al., in the Adult Math Project (AMP), as already indicated, included two phases to investigate shopping (as have most of the other studies discussed in Secs. 7.3 ad 7.4. The supermarket ethnography described subjects doing their weekly shopping <u>in situ</u>, and recorded their accounts of their actions; see above. In the "best buy simulation" phase of the research, they gave 12 such problems to each of their subjects (n = 24).

Some initial questions were also asked to learn more about the context of any possible calculations for each subject:

> When you go shopping, do you ever find yourself comparing two items in order to find out which one gives you the most for your money? ... About how often (e.g. on the order of once a shop, once a week, etc.)? ... How do you figure out which one is the best buy? (e.g. mental arithmetic, paper and pencil, calculator, other) ... Have you ever got into a situation where you couldn't figure this out using (the mentioned method)? If so, what do you do?
>
> (Lave, 1988, pp.105-106)

The best buy simulation phase was conducted in subjects' homes. (NOTE 16, Ch.7)

Here are some of the findings of the two best-buy studies:
(i) Overall, Lave et al. reported 91% of attempts of the most common type of simulation (93% overall) resulted in <u>correct answers</u> - i.e. the correct choice of "best buy". This disaggregated to 99% for easy ratios, as compared with 84% for more difficult ratios on (derived from Table 14, p.109). (NOTE 17, Ch.7) Because of their theoretical perspective (see sec. 7.4.3) Capon and Kuhn did not report comparable results, but focussed on the use of "conceptually

correct" strategies, viz. (5) and (6).

(ii) For strategy use, see Table 10.7(a). Capon and Kuhn reported 55% of the subjects' answers to the two questions were "conceptually correct", i.e. used strategies (5) or (6), only 30% of answers using strategy (6) itself. When inferential errors were deducted, the results on the deodorant problem (the only one for which the results can be reconstructed from the original articles) decreased from 53% "conceptually correct" to 47% "correct". (Arithmetic errors were disregarded.) Strategy (4), using differences, was used by 7% overall. For Lave et al., the figure was 86% (for 8 of their 12 problems designated as "P/Q ratio-type" (NOTE 19a, Ch.7).

(iii) Capon and Kuhn (with only 2 questions of course) reported 69% of subjects as using one strategy, and 31% using two strategies. On AMP, using 12 questions, all the subjects used 3 or 4 strategies.

(iv) In Capon and Kuhn's study, there was a correlation between "level of strategy" used and level of formal education in the Cambridge Mass. sample (n = 100, of which a striking 53% had been to college).

For discussion of these results, see sec. 7.4.3.

APPENDIX W6 The structure of everyday activity: Geoffrey Saxe

In his recent work, Geoffrey Saxe (1991a, 1991b) has responded to what he perceives as the shortcomings of the theories of Piaget and Vygotsky, in terms of their being able to explain how "the mathematical understandings that have emerged over the history of a cultural group become the child's own, interwoven with the child's purposive problem-solving activities" (1991b, p.230). Therefore, he aims to develop a new level of analysis - activity in a sociohistorical context - where "culture and cognition are constitutive of each other" (1991a, p.184). Thus his aims are similar to Lave's.

As in studies reviewed above, this research combined phases of intensive observation and simulation, or in this case, one-to-one testing. The subjects of the relevant studies were child candy-sellers (age 5 to 16) in the city streets of Recife in north-eastern Brazil; these children were different from the market-sellers in Carraher, Carraher and Schliemann (1985), since all but the youngest here were themselves responsible for pricing, etc. (Carraher, 1991). The study was carried out during a time of inflation, so that the sellers needed to be flexible and to learn from changing situations.

APPENDIX X1 Maths Anxiety as a Mass Phenomenon: Sheila Tobias

Sheila Tobias' work, beginning with an article in _Ms_ magazine in the USA in 1976, and including _Overcoming Maths Anxiety_ (1978), has been exceedingly influential in popularising the notion of "maths anxiety". Her position seems to be that readers will know when they have it. For Tobias, maths failure often goes through a series of stages:
(1) a latency stage, before becoming obvious oneself or to others, such as teachers; followed by
(2) an acute "attack" of "failing at Maths" which feels like "sudden death" and is very frightening; followed by
(3) a chronic feeling of "utter defeat", a feeling that one would "never go any further in mathematics", characterised by feelings of paranoia and inauthenticity: "everyone will find out how dumb I am" (1978, pp.44-5). These chronic feelings may - and often do - last a lifetime, and lead to avoidance of maths courses, and presumably of numerate experiences, and to lower performance in maths.

Examples of the "acute attack" are given in the diagnostic interviews later in the book; for example,

> In elementary school I was always in the top maths group, although I could never figure out why. Then in fifth grade [around age 10] I got a C on a test. That had never happened before. I began going to my father for help with my math.
>
> (Interview 1 in Tobias, 1978, p.250)

> I stopped taking maths in my sophomore year in high school [around age 15] after a really bad experience with geometry. [...] I just hated memorising all those theorems and even though I had done well in algebra I was failing geometry.
>
> (Interview 2 in Tobias, 1978, p.253)

Both of these quotes were from women. The importance of the first woman's father in her "maths autobiography" is noted.

Tobias' set of stages in the development of maths anxiety is of course subject to the same problems as are stage theories generally. It proposes a uniform sequence: latency - acute attack - chronic defeatism, which is supposed to be universal. However, the problem is that the first two stages _could_ describe experiences which almost every one would have, and the crucial question would be about what leads some, but not others, on to the third stage. Seen from this critical point of view, the "acute attack" may be a rather spectacular label for a fairly common experience - and may produce the risk of "creating" mathematics anxiety, through the regulation of the way that students and their teachers interpret the vagaries of progress on the necessarily rocky road to learning.

In such studies it is important to question the _sources_ of maths anxiety: "What's so special about maths?" According to Tobias (1978, Ch.2), there are several special qualities of maths - or of _beliefs_ about maths - which make anxiety in this area particularly likely. First, there are myths about maths: that there always is one right answer, that maths is inaccessible because of its "abstraction". Second, there are myths about learning maths: that, since learning maths is cumulative, if you miss one stage, through illness, or because you didn't ask enough questions when you were younger, you can never catch up (p.55); or that you need a "mathematical mind", which, according to the myth, few people have. (Sometimes teachers or parents appear to be reinforcing this latter myth, especially if they believe themselves to possess such a mind and find it difficult to understand the students' difficulties.) Third, the language of mathematics is seen as ambiguous or misleading: "multiplying" does not always lead to making the number greater, and the "least common denominator" is not "uncommon" in any everyday sense. Finally, maths anxiety may be related to the following feelings:

- distrust of one's own intuition;
- inability to handle frustration;
- lack of confidence, and self-defeating "self talk";
- a lack of safety with consequent unwillingness to take risks;
- fear of being too stupid or too smart / successful; and/or
- excessive dependence on teacher or on the text (pp.58-67).

Tobias mentions the sorts of gender differences in maths performance, avoidance and self-reported anxiety reported in Chs. 2 and 3 of this thesis. Yet she is wary of focussing on maths anxiety as one more "female disability": "men have math anxiety too, but it disables women more" (pp.97-98).

Tobias has provided compelling description of maths anxiety and also a basis for practical interventions aiming to help individuals to overcome maths anxiety. In this work, she relies on her maths diagnostic interviews (see above), as well as asking the person to write maths biographies, keep maths diaries, and engage in "constructive self-talk" (1978, pp. 67-68).

APPENDIX X2 Affect in ethnographic and case studies

In general, ethnographic studies are oriented to relatively broad areas so that findings relevant to maths affect are necessarily spread thin. For example, a study of young women engineering trainees (Griffin, 1985) found that tutors were struck by the trainees' "complex attitude":

> It's the schools, they say they all hate maths and can't tell a meter from a millimeter, but they love the maths lessons here.
> [...]
> Some of the girls don't know any maths, they can't add up. But you can't diddle them out of money. And they know their rights....
>
> (Griffin, 1985, pp.171-72)

That is, the trainees's feelings about maths depend on the context: college maths differs (according to the tutors) from school maths, and both differ from what was earlier (e.g. Sec.6.1) called "money maths".

Other researchers have pointed to the inseparability of affect and cognition in solving problems. For example, Ginsburg and Asmussen (1988) argue that the tremendous problems associated with the learning of mathematics could not possibly arise only from basic cognitive defects. They therefore focus on non-cognitive, mostly affective, explanations, and argue that a case study approach is needed.

In their study, they conducted eight semi-structured "sessions" with each of six adults, discussing the subjects' feelings towards mathematics, experience with informal and school maths, and recollections about parents' and teachers' attitudes towards maths attainment. They also administered a projective test on conflicts and concerns about schooling, and the MARS (Mathematics Anxiety Rating Scale - see Ch.3), followed by a discussion with each subject on his or her responses. They present their results in terms of a general discussion of biography / development for two of the subjects (pp.98-107).

They draw several conclusions. First, mathematical thinking is "hot": it is more than the use of cognitive processes like knowledge, procedures and strategies; it is also bound up with non-cognitive factors such as beliefs, cognitive style, motivation, confidence, anxiety and identity. Further, these factors interact in a complex dynamic, where the direction of causality may be in both directions. For example, for one of the interviewees (woman, aged 30+), not only did anxiety seem to influence effort and learning (which in turn influence anxiety), but also affect seems to be part of cognitive activity: "When Jessica was in an evaluation situation, anxiety was part of her mathematical work, just as much as her operations on numbers." (p.103).

APPENDIX X3 Emotion as the dynamic of reason: Laurie Buxton

Another very important book in disseminating the idea of maths anxiety has been Laurie Buxton's Do You Panic About Maths?: Coping with maths anxiety (1981). He explicitly bases his work on a "cybernetic" theory of learning as a goal-directed activity (Skemp, 1979) (see NOTE 2, Ch.8), and argues for the inseparability of cognition and emotion:

> It is inappropriate to believe that there is such a thing as the cognitive power of a particular person. We operate well or badly in learning, and more especially in problem-solving, acording to the drive provided by our emotions. Reason is powered by motion, or, more often, hampered by it.
>
> (Buxton, 1991, p.3)

He distinguishes three levels of rejection of mathematics:
- simple boredom or lack of "affinity";
- a feeling that maths offends commonsense (e.g. in the idea

that the product of two negative numbers is positive), and a consequent lack of belief or of "emotional acceptance"; and
- panic, a "clearly recognizable (if not easily definable) state of mind". This is a "sudden discontinuity of behaviour" following a buildup of tension, which can become frenzy, or more likely in the case of maths, "a sense of paralysis, a freezing of the mind, linked often with physical tension and rigidity" (1981, pp.4-5). Only panic is "pathological" (1991).

Buxton's work included three modes of enquiry. First, a set of one-off exploratory interviews. Next, a series of group meetings (4 women, 3 men) over one academic year, where the aims were to explore negative feelings about maths, and to learn some maths (with Buxton, an Inner London maths inspector at the time, as teacher); since he gave members of the group some maths problems to do, Buxton was able to observe panic and anxiety at first-hand, as well as discussing them. Finally a series of some twenty interviews each with a small number of adults (3 women).

His account of the origins of maths anxiety includes the following factors:
- unpleasurable or distressing feedback;
- the apparently arbitrary rules;
- the ambiguity of jargon (e.g. "x is unkown"); and
- the moral connotations of "right" and "wrong" answers.

He particularly emphasises the importance of time pressure in the classroom, and early unhappy encounters around maths with "authority figures" - teachers or parents. He deploys his theoretical model to show how mathematical thinking is undermined by time pressure and the threat of disapproval.

Buxton does not speculate on whether there were gender differences in experiences of maths panic (or even in willingness to report it) - appropriately, in view of his very small, mostly female, sample. However, given that other studies have found gender differences in affect, he offers two explanations. The first is in terms of "attitudes to authority":

> It may be that, in a culture where girls are expected to conform to authority and boys are more heavily punished, but, curiously, less disapproved of for breaking rules, that later progress in mathematics is gender-biased.
>
> (Buxton, 1991, p.4)

Second, responding to the metaphor used by two subjects, of mathematics as a "secret garden" into which they could not enter - itself a metaphor in psychoanalytic approaches for sex, Buxton speculates whether gender differences in feelings about sex might explain gender differences in emotions about maths (1981, pp.123-5). He also briefly explores the what might be the meanings in superego terms of "right" and "wrong" answers (pp.121-2).

Thus Buxton argues clearly for the inseparability of emotion from mathematical learning and problem-solving. His work also points to the need to engage with psychoanalytic ideas.